

WORKSTATION APPLICATIONS SOFTWARE

WESTERN EUROPE

1989 - 1994

INPUT

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Market Analysis Programme—Europe

***Workstation Applications Software—
Western Europe, 1989-1994***

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Abstract

This report examines the trends, opportunities, and issues that are affecting vendors of workstation application software products. Developments in the different European country markets and the major application areas are reviewed. The key issues impacting the development of the user environment are analysed.

Market size and growth figures are included, with breakdowns by country, industry sector and cross-industry application. The major issues affecting the workstation market, (platform and system and application software), are discussed in detail, with recommendations for vendors.

This report contains 161 pages, including 63 exhibits.

14 May 1990

Dear Market Analysis Programme Client:

**WORKSTATION SOFTWARE OPPORTUNITIES, WESTERN EUROPE
1989-1994**

I am pleased to enclose your copy of the report, Workstation Software Opportunities Western Europe 1989-1994, which is part of INPUT's Market Analysis Programme, Europe.

The report will provide you with an analytical assessment of the market potential. The report contains perceptions and needs of end users, essential information to enable you to plan new products or enhancements or to enter the market for the first time. Standardisation is still a vital issue to be tackled and the report contains an in-depth discussion on UNIX.

Major vendors are profiled and the report surveys the software available for numerous applications, both industry specific and cross industry, with market forecasts for each over the five-year period 1989-1994. Market drivers and inhibitors discussed with regard to their effect on the market for vendors. The report concludes with recommendations to vendors on strategies to employ to take best advantage of the opportunities available.

I trust that you find the report interesting and useful for your strategic planning. Your comments are welcome, and I would be grateful if you would complete and return the enclosed questionnaire. If you have any questions, please do not hesitate to contact me.

Yours sincerely,



Tim Stevens
Senior Consultant

Enclosure

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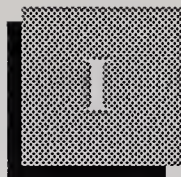
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Introduction





Introduction

A

Scope and Objectives

This report is produced by INPUT as part of its 1989 European research programme for software and services. The focus of the report is towards the medium-sized and larger corporate users seeking to implement distributed processing solutions with a high degree of extensibility to cater for expanding and evolving needs as Western Europe moves towards a single European market.

The increasing trend towards standard application software products is changing the way vendors are approaching the market. This trend, along with the growing internationalisation of the Western European market, has resulted in partnerships and the use of CASE tools in customising application software products.

INPUT's objectives in this report are to establish an overall view of the Western European market for workstation application software in order to provide vendors with an analytical assessment of market potential. The report covers all of Western Europe, with the largest country markets—France, the U.K., West Germany and Italy—being dealt with in the most detail. The report also covers Benelux, Scandinavia and Spain.

The report reviews and analyses the issues, trends and market forecasts for the Western European market for workstation application software. The emphasis of the report is on the perceptions and needs of end users, and on the emerging technologies that affect the development of the workstation application software market.

Vendors interested in the needs and plans of end users will be able to use this report to identify the opportunities in the market to either extend market share or to enter the workstation software market for the first time.

The market size and forecast figures refer specifically to standard workstation application packages, unless otherwise stated. Included as user

expenditures are lease and purchase expenditures, as well as fees for work performed by the vendor to implement and maintain the package. Fees for work performed by organisations other than the package vendor are counted as professional services.

B

Methodology

The report addresses the workstation application software market in Western Europe.

Primary research for the report came from two main sources:

- Telephone interviews with individuals from 200 user organisations who were either IS managers or members of line management at subsidiary or departmental level.
- In-depth personal interviews with managers in 30 vendor companies, including equipment vendors, systems integrators and independent software producers.

Appendix B gives the breakdown of user interviews by country and shows the actual totals in each category. The user sample was analysed by size of establishment, as follows:

- More than 1,000 employees
- More than 500 employees
- All establishments

The sample was thus evenly balanced between the two establishment staff size groups, so as to cover the needs of both the medium-sized and the larger user.

Appendix B shows the breakdown of the vendor sample by country. Many of the vendors interviewed offered products across the whole of Western Europe. Their marketing strategy varied little from country to country, and pricing was mainly geared to the prevailing currency exchange rates between vendors' domestic and overseas markets.

C

Report Structure

The report is organised as follows:

Chapter II is an Executive Overview of the main points of the report.

Chapter III contains an analytical overview of the workstation software market as a new opportunity for vendors, setting out the principal reasons for the market's development.

Chapter IV provides extensive market forecasts with respect to how users are charged for workstation software products and a discussion of the software products competitive environment.

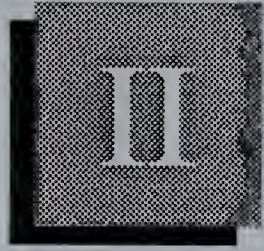
Chapter V provides an analysis of both the application and system software markets. The application sector is divided into cross-industry and industry-specific markets, with market forecasts. The market drivers and inhibitors are discussed.

Chapter VI provides a detailed analysis of the product development issues in Western Europe, within the framework of the industry's structural changes. The technical, user and organisational issues are discussed, as well as the opportunities for workstation application software.

Chapter VII develops INPUT's analysis of the marketing challenges and the future opportunities available to vendors over the period 1989-1994.

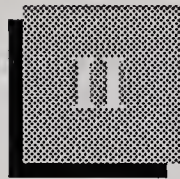
Chapter VIII contains recommendations to vendors on the development of the workstation software market.

Appendix A contains a definition of terms and Appendix B an analysis of the research sample. Appendixes C and D are copies of the vendor and user questionnaires. Appendix E contains detailed forecast data.



Executive Overview





Executive Overview

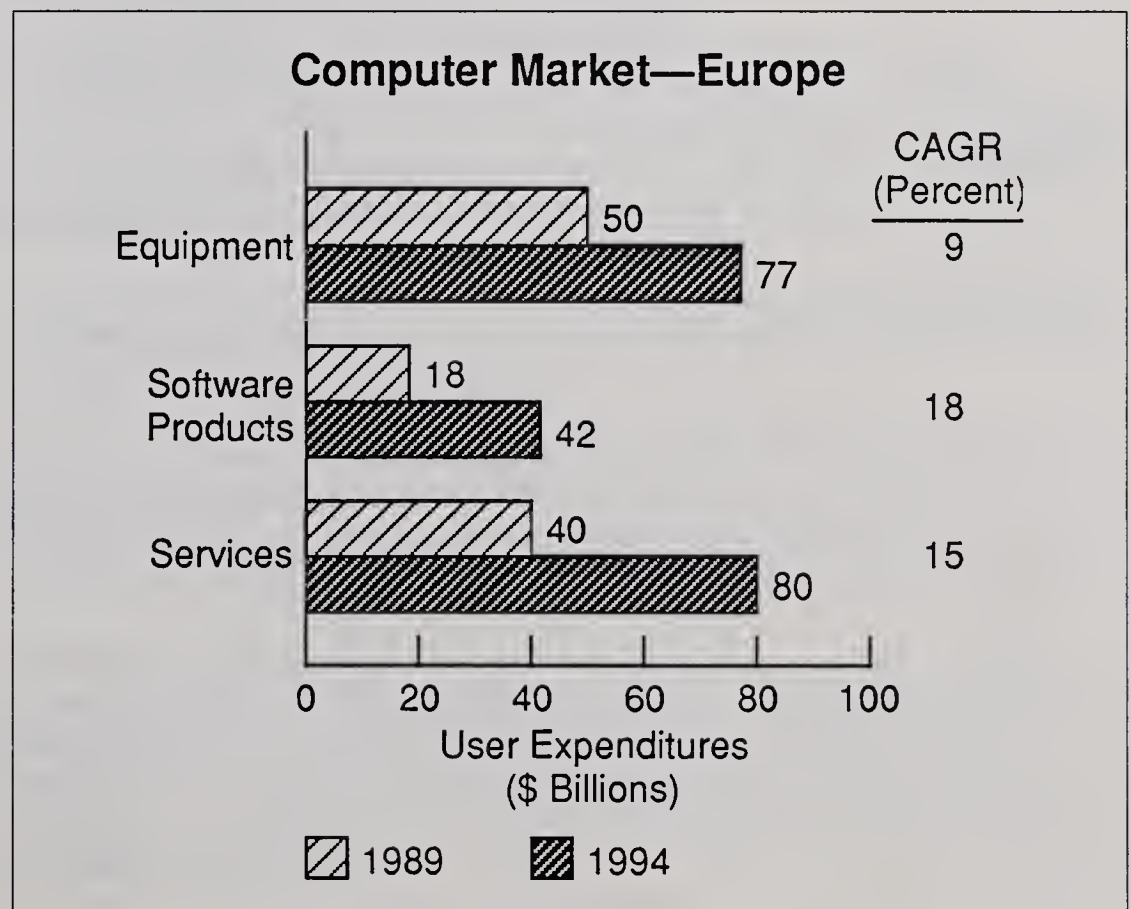
A

Software and Services Market

In the European computer market, expenditures for software and services together already exceed expenditures on equipment. The current structure of the market, analysed in this component form, is shown in Exhibit II-1.

The software products sector can be seen from this exhibit to be the smallest of the three sectors, but the fastest growing. The services sector, which contains the customer services (equipment maintenance) subsector, is effectively static, thus emphasising the high growth of the professional services element, which accounts for the bulk of the revenue.

EXHIBIT II-1



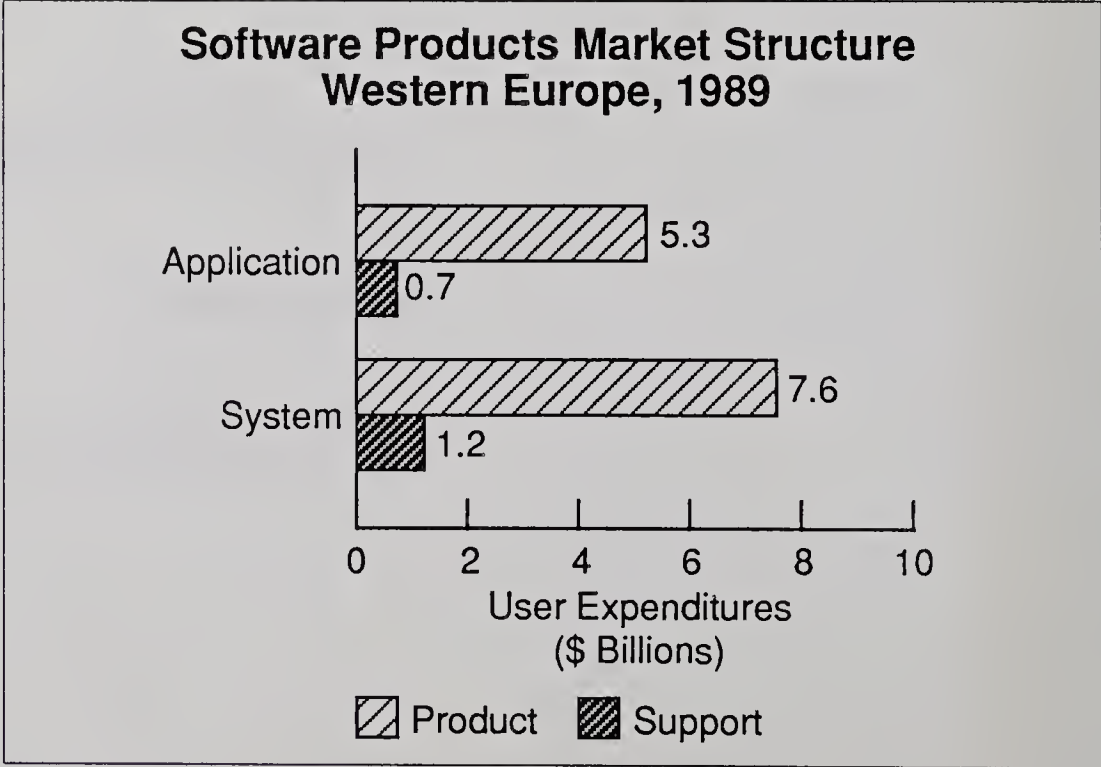
The percentage of the market represented by equipment is shrinking, from around 45% in 1989 to below 40% in 1994. This forecast shift in the balance of information system and service components clearly underlines why increasing emphasis is being placed by equipment vendors on selling service solutions.

INPUT’s market assessment measures delivery modes from an end-user perspective. A number of these modes—turnkey systems and systems integration in particular—are combinations of equipment, software products and professional services. Vendors faced with increasing market pressure for solutions have to judge the competing claims of the following service solutions:

- To sell software application products independently of any other service product other than the professional services support of these products
- To provide software product applications and the necessary equipment and services as a combined turnkey package
- To be a developer of custom-designed software that could be included in an overall systems integration contract containing the necessary equipment

Exhibit II-2 shows a further level of analysis of the software product market not including sales of equipment. This portion represents some \$15 billion of the \$18 billion shown in Exhibit II-1. It can be seen from Exhibit II-2 that system software outweighs application products.

EXHIBIT II-2



Software products are sold by equipment vendors and independents and there exists a clear bias between these two groups for system and application software.

- Equipment vendors account for some 80% of the system software market, and independent vendors for some 60% of the application software market.

Of the various subsectors within the software products industry, there are four which will feel the impact of the growth of workstations. These can be summarised as follows:

- The IBM midrange, including AS/400 and the System 3X series which it replaces
- The Digital middle range VAX and VAX workstations area
- High-performance desktop workstations often used for technical and engineering computer-intensive applications, and increasingly run (as a result of Sun Microsystems' sector leadership) under the UNIX operating system
- The rest of the nonproprietary operating systems sectors, including UNIX, PICK and MUMPS (but excluding MS-DOS and the emerging OS/2 as essentially related to desktop single-user applications)

On the application side, IBM offers only a few products, but these include major software products such as Office Vision/400 for office automation and MAAPICS for the manufacturing industry. The presence of these products in the workstation market, however, has been undermined by the relative unpopularity of IBM's RT machine.

The blurring in the distinction between the low-end mini, the workstation and the high-end PC will result in a substantial realignment of the market.

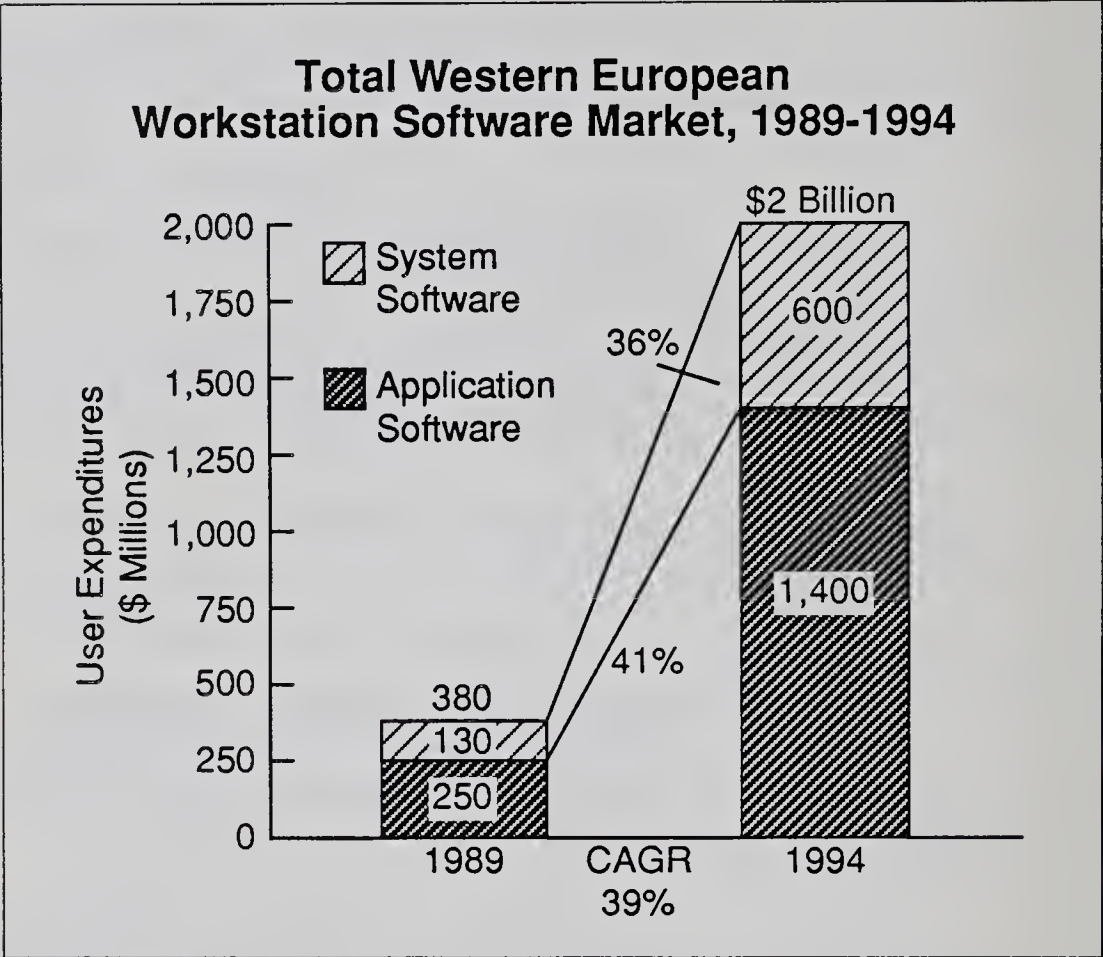
B

The Workstation Software Market

INPUT estimates that the market for workstation software is \$380 million, with the application sector accounting for 65% of that total. The application sector is growing at a compound annual growth rate (CAGR) of 41% and will be worth \$1.4 billion in 1994, as shown in Exhibit II-3.

This figure reflects a higher growth rate than for any other part of the software products market. Workstation system software will also show a high CAGR (36%) compared to the relatively low growth rates for mainframe (10%) and minicomputer (21%) software. The distinction between the workstation and the more powerful personal computer will inevitably become blurred.

EXHIBIT II-3



The strong growth anticipated for workstation software can be explained by its low base (less than 5% of the total software products market), and by the strong trend towards distributed processing and client/server implementations.

C

Competitive Environment

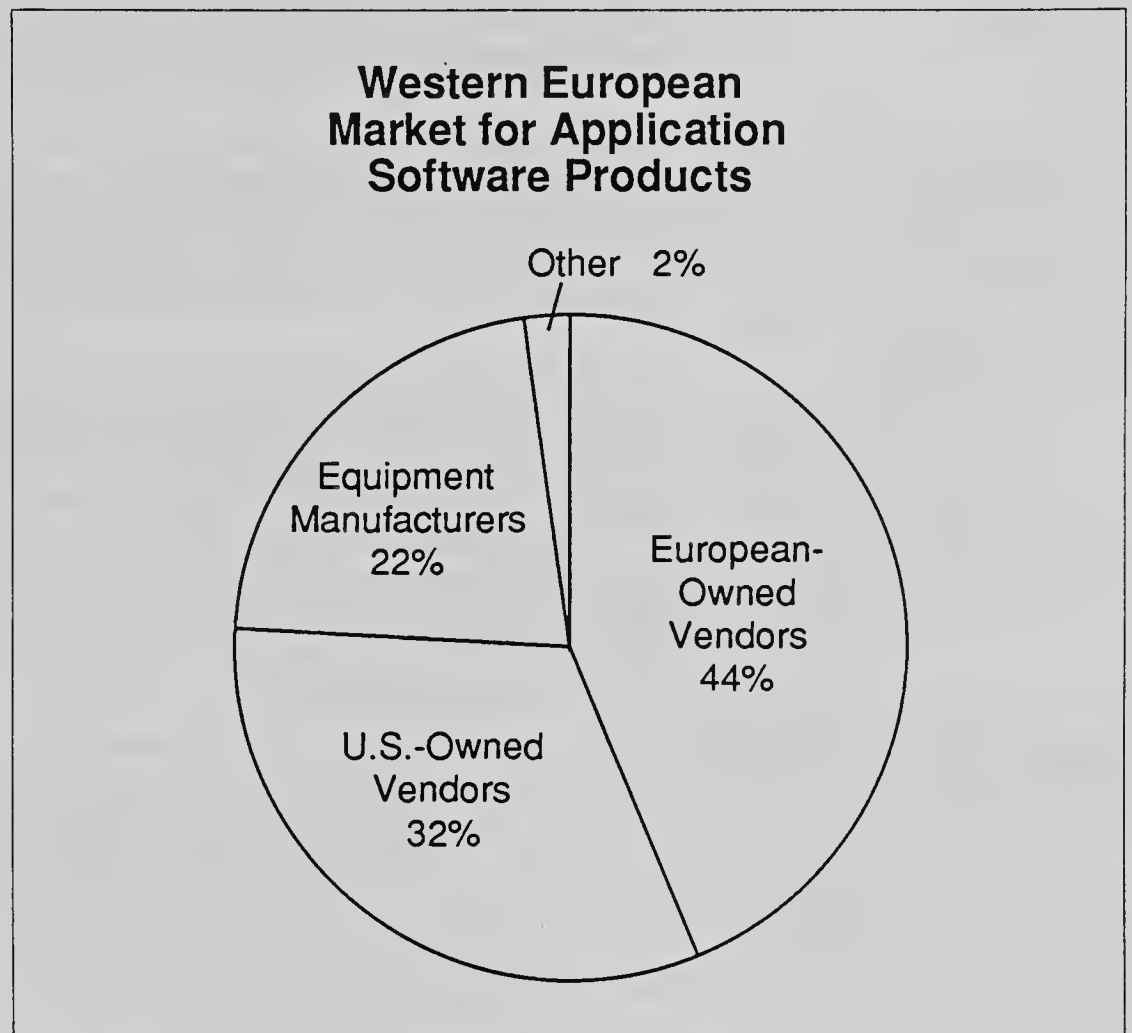
INPUT broadly segments the Western European market for application software products as follows:

- | | |
|--------------------------------------|-----|
| • European-owned independent vendors | 44% |
| • U.S.-owned independent vendors | 32% |
| • Equipment manufacturers | 22% |
| • Others | 2% |

(See Exhibit II-4)

European-owned independent vendors are the most numerous. They are mainly small companies that confine themselves to their domestic markets. By far the largest company in this category is the West German company SAP.

EXHIBIT II-4



The leading U.S.-owned independent vendors (e.g., Lotus, Microsoft) have significant revenues in most European countries. These companies and others are now looking to Europe for more of their business, as the growth rate of the European market is higher than in the U.S. Many of the smaller U.S.-owned vendors are either establishing subsidiaries in Europe or are operating through European representatives (e.g., Autodesk). Lotus and Sun have recently arrived at an important agreement for the 1-2-3 product family, and Ashton-Tate will be offering a UNIX version of dBase IV in 1990.

The main equipment manufacturers in the Western European marketplace are IBM, Digital, Siemens and Olivetti. All of these companies have been concentrating their efforts more on application software products than they have in the past, and the IBM RT is an eagerly awaited workstation for 1990. Their software offerings are being done partly through partnership agreements with independent vendors and in other cases (notably Olivetti) through the acquisition of software companies.

However, in the workstation software market, the majority of workstation software vendors are U.S.-owned independent vendors with distributors

in key European markets. The pan-European nature of the product range is a common feature of the workstation software market.

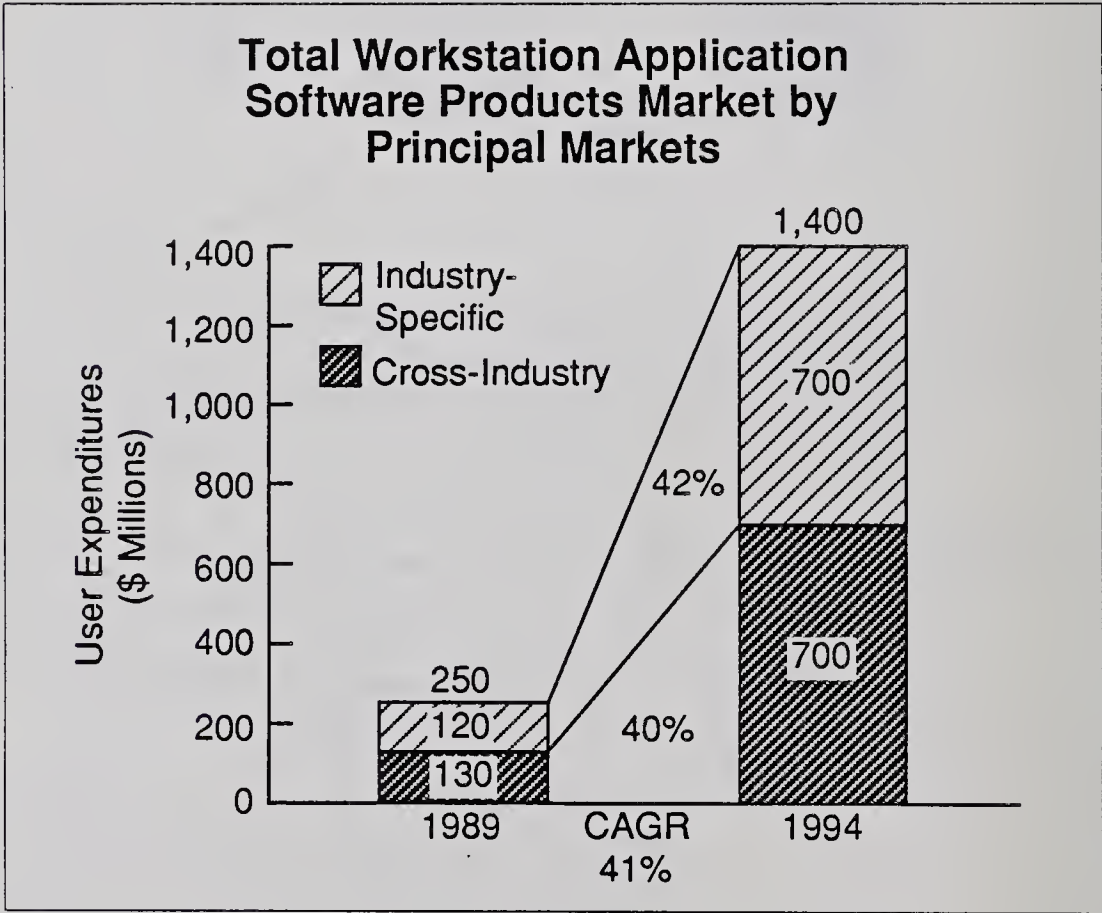
D

Workstation
Application
Software—
Industry-Specific and
Cross-Industry

The workstation application software segment consists of two categories as defined by INPUT—industry-specific and cross-industry software. Industry-specific products address the functional requirements of particular industries, such as discrete manufacturing with MRPII.

Cross-industry application software provides solutions that can apply to common functions in any industry (i.e., office systems, accounting, education and training). Exhibit II-5 shows the size of these two market segments in 1989 and INPUT’s projection of these application groups for 1994. The industry-specific sector is expected to grow at a CAGR of 42%, whilst the cross-industry sector is expected to grow at a slightly slower rate of 40% over the forecast period. By 1994, industry-specific and cross-industry applications will each have 50% of the market for workstation application products.

EXHIBIT II-5



The key factors driving the workstation application software market are the popularity of the client/server architecture in distributed processing, and the cost-per-mips attributes of the workstation against the main-frames and the minis. The increasing sophistication and functionality of

workstation and PC-based software is contributing to the forces driving the workstation application software market.

The perennial *bete noire* of the software and services industry—standards—is the major inhibitor to the development of the workstation market. There is much confusion over standards, particularly in the operating system area. A full discussion of UNIX and standards is in Chapter VI.

E

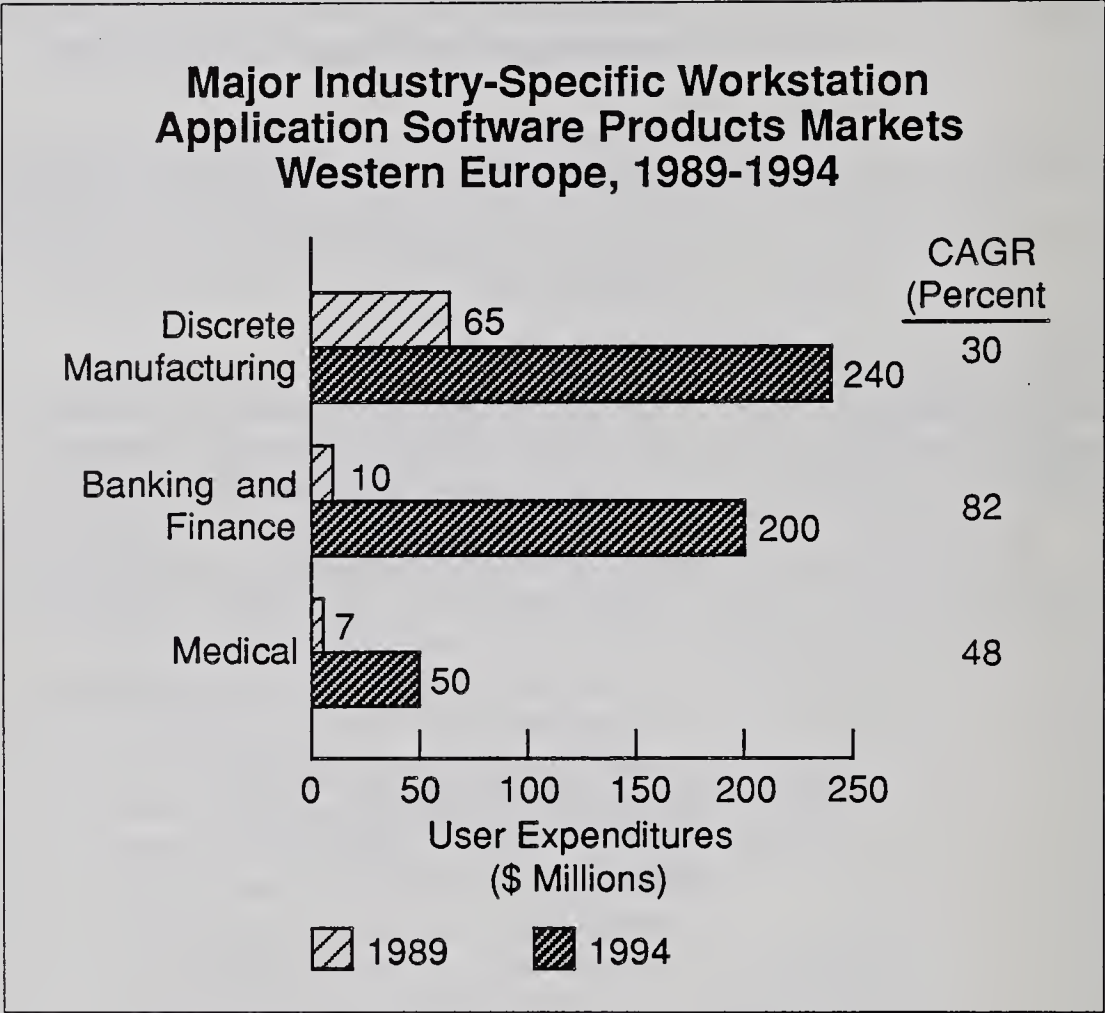
Major Industry-Specific Markets

The largest industry-specific market is discrete manufacturing. The manufacturing sector is particularly important as users attempt to improve their performance through automation. Vendors are now advocating integrated systems that embrace every stage of the manufacturing life cycle as well as link manufacturing applications to non-manufacturing applications such as distribution and, potentially, accounting.

The banking and finance sector is also an inevitable opportunity, with applications software increasingly being supplied by third-party software companies, reducing the proportion developed in-house. Banks are being compelled to look at standard solutions where possible in order to reduce costs. However, the demand for custom software will remain strong as banks and other financial institutions strive for competitive advantage by providing services not offered elsewhere. Major application areas include customer service, platform/teller automation and executive information automation. The move from dumb terminals and dedicated word processing hardware to integrated smart workstations providing a variety of applications on one piece of hardware contributes directly to the size and growth of the banking and finance market.

As shown in Exhibit II-6, INPUT predicts a CAGR of 30% for the discrete manufacturing sector and 82% for the banking and finance sector, resulting in an increase in market size from just under \$10 million in 1989 to just over \$200 million in 1994. This staggering increase is indicative of the huge untapped market in banking and finance.

EXHIBIT II-6



F

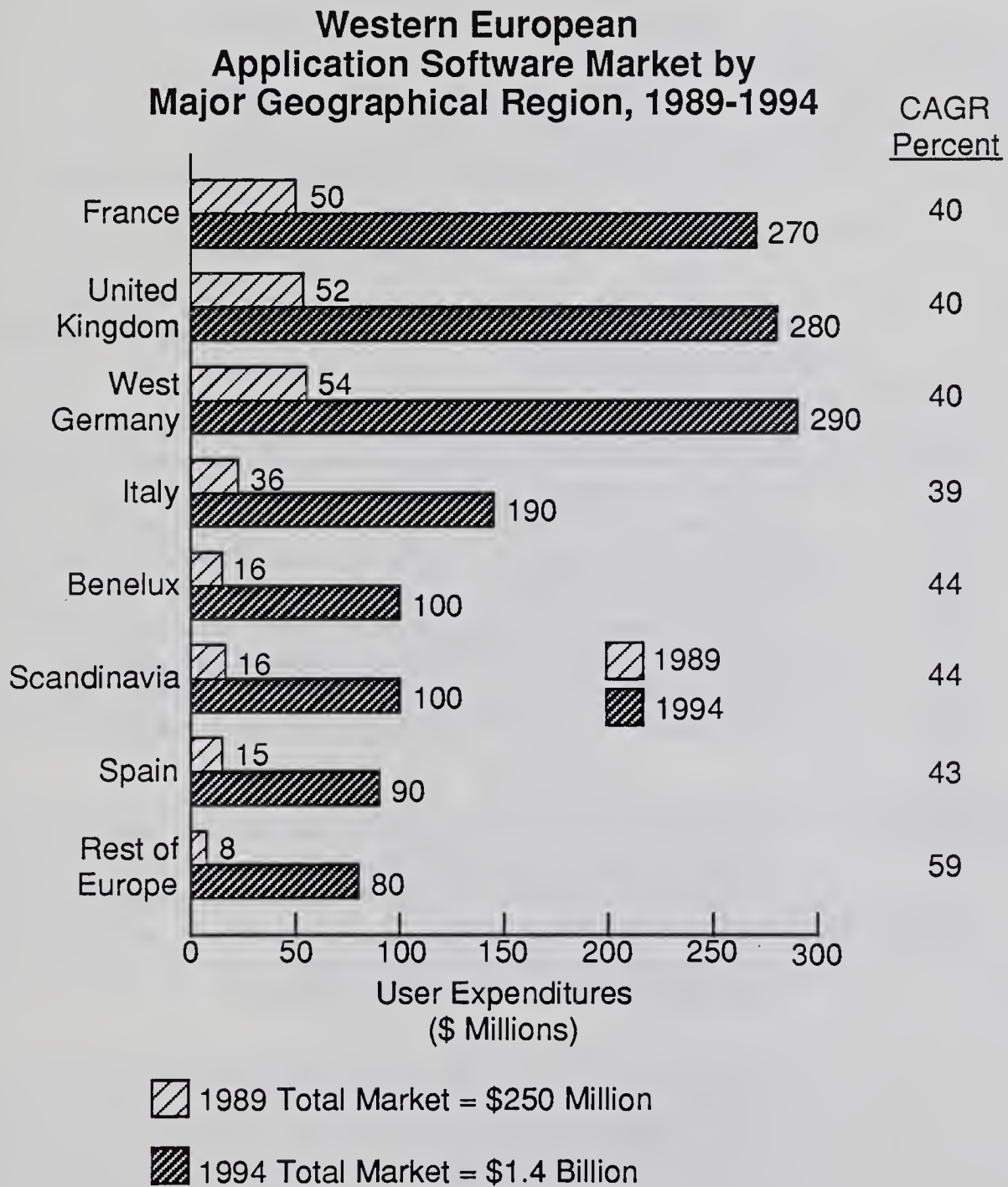
Country Market Breakdown

Exhibit II-7 gives a breakdown of the Western European workstation application software products market by country. The three major markets—West Germany, the U.K. and France—together account for over 60% of the market. Growth rates in all three countries are expected to exceed 40% over the forecast period.

The Spanish market is expected to increase at the fastest rate, reflecting the rapid growth of equipment in the country and the development of standard software packages for workstations.

There is a growing recognition amongst application software product vendors of the benefits to be gained from working in partnership with other companies. These partnerships vary from informal arrangements to official joint marketing or product development agreements.

EXHIBIT II-7



There are three types of partnership agreement being carried out in Western Europe; these are listed in Exhibit II-8. Agreements involving two software companies can be particularly attractive for companies seeking to enter foreign markets. They can also be mutually beneficial when the product portfolios of the two companies complement one another.

EXHIBIT II-8

Vendor Partnerships

- Software company partnerships
- Equipment vendors/software companies
- Vendor/client agreements

Vendors interviewed by INPUT saw significant advantages to be gained from cooperation between equipment manufacturers and independent application software product vendors. The general consensus is that these two types of vendor do not often compete directly, but can leverage business for one another. Equipment manufacturers cannot supply all the software needed by their customers and hence need the support of third-party vendors. Also, independent software vendors need access to the distribution networks of the large equipment manufacturers. Partnerships involving a vendor and a client are less common, although this may well become an attractive alternative for new product development.

G**Recommendations**

A basic strategy for software product success is to provide the best possible product to the users; staying on the leading edge of technology and application features is the most important aspect of being a successful software provider. The products have to take advantage of the most current technology as well as provide the user with ease of use and valuable functions for the intended purpose.

The second product strategy is providing integrated products. The primary strategy is to cover the customer's universe with as many integrated platform applications as possible—the applications should run between incompatible devices within the size group or across hardware size categories. In cases where vendors have concentrated on one or two applications, they should provide those applications with the capabilities to port to other platforms, or to provide file-compatible interfaces to other non-compatible application software.

Support strategies relate to the way the vendor supports the client after they have been developed. The first strategy is providing actual client support in terms of centralised technical support, education and training, seminars, consulting and application planning as well as software fixes

and upgrades. Users require additional vendor personnel who are knowledgeable and provide better service support.

Specialised channel support and separate divisions providing related professional services for software users are other areas vendors should address. Vendors should focus the types of channel support to maximise the potential of each. Professional services departments or divisions address the specialised consulting and support service needs of users.

A summary of recommendations appears in Exhibit II-9.

EXHIBIT II-9

Recommendations

Application Software Opportunities

Product

- Approach to standards
- Integrated software
- Graphical user interface

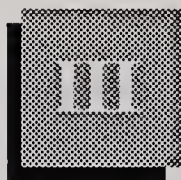
Marketing

- Joint ventures
- Support services



Market Overview





Market Overview

A

Workstations as a New Opportunity

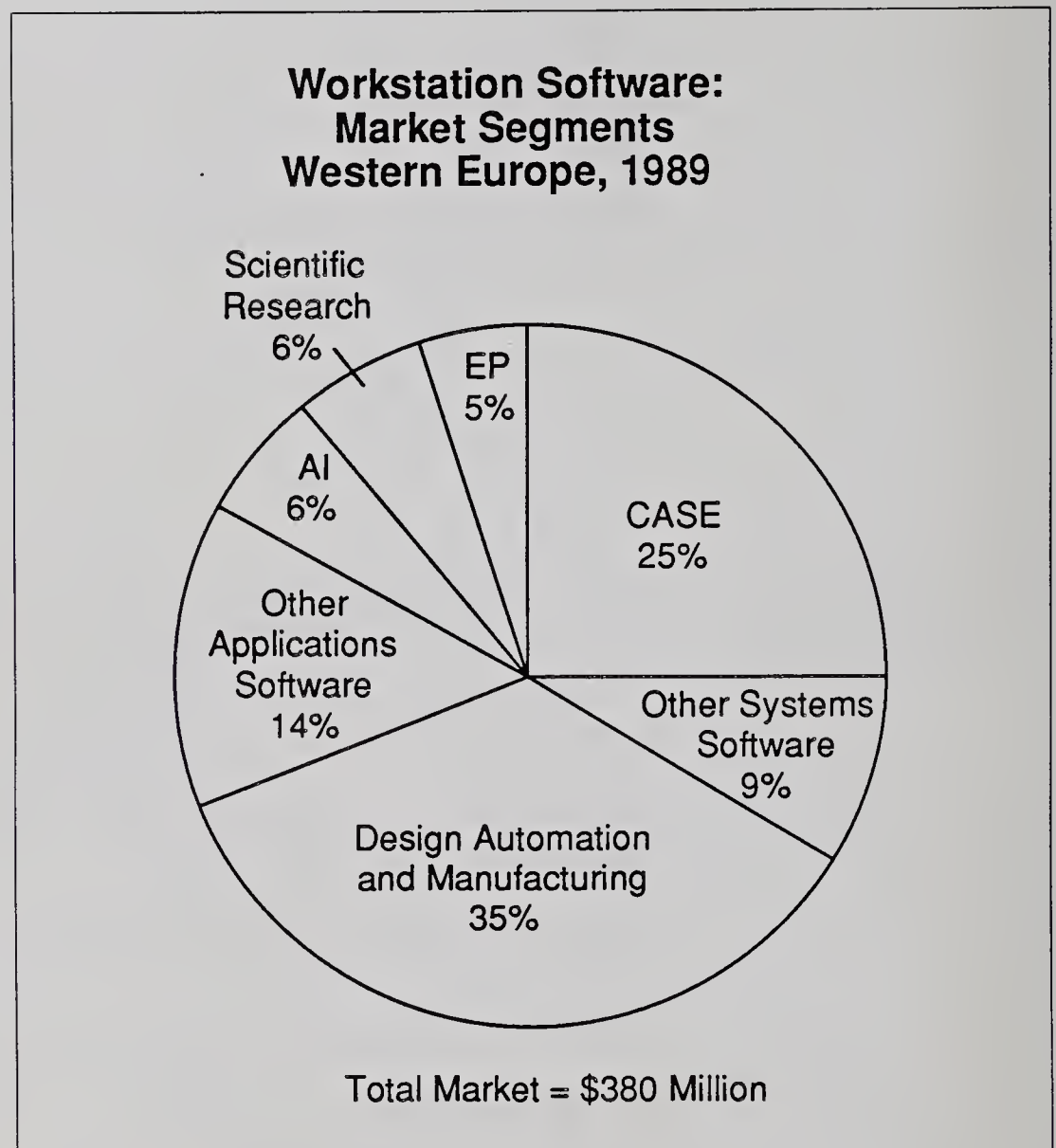
The workstation segment is a new platform category broken out from the earlier categories. It includes high-performance desktop configurations such as those provided by Sun Microsystems, HP/Apollo and Digital. Although configured either standalone or networked, they are distinguished from the midrange systems category by application (they are still being used in primarily technical applications) and by architectural pedigree (they were initially developed as high-performance single-user engines capable of cooperative networking).

INPUT is focussing attention on the workstation application software market for the following reasons:

- Cooperative networked computing is becoming commonplace
- Departmental office automation has become an active ingredient in proactive corporate information systems
- The mainframe is adopting the role of a server—whether for a database, a network or an application. Personal computers are communicating with one another without the need for mainframe intervention, thus opening the market for the multifunction workstation.
- Mainframes are becoming repositories of corporate data and points of control and management.

Currently, the largest market subsectors for workstation software are in the discrete manufacturing and design automation subsectors (CAD/CAM, CAE, EDA), with a 35% market share; and CASE (computer-aided software engineering), with 25% of the market. INPUT anticipates, however, that the market for banking and financial and other numeric-orientated applications—as developed currently by Lotus, Microsoft and Ashton-Tate—will make large inroads into the workstation software market. A market segment breakdown appears in Exhibit III-1.

EXHIBIT III-1



1. Market Dynamics

In 1989, the technical workstation market saw enormous changes among the market leaders and subtle evolutionary shifts in the market as a whole: Sun Microsystems experienced difficulties, and Hewlett-Packard and Apollo merged. New products from Digital, Data General, MIPS Computer Systems and NeXT Inc. appeared.

Although Sun, Digital and HP/Apollo are clear market leaders, other U.S. companies such as Intergraph Corp.—with its Clipper-based reduced instruction set computing (RISC) workstations—Silicon Graphics and Tektronix Inc. are all in the workstation vendor top ten. The hitherto quiet IBM announced vast power and new enhancements to come for the RT workstation, as well as an expanded interest in the workstation as a strategic product segment; this announcement was confirmed by the launch of IBM's RT range in early 1990.

Price/performance wars became the key issue, with announcements from Digital and Sun countering one another with successively lower entry-level prices. HP and Silicon Graphics also cut prices. However, INPUT's research leads it to conclude that connectivity and functionality will displace price/performance as the key issue in the 1990s.

a. Workstation Vendors' Market Position

The single most significant event of 1989 was arguably HP's \$476 million acquisition of Apollo, the newly merged company displacing Sun for the first time as the leading workstation vendor. Though the merger is unquestionably a natural fit—Apollo has good products, innovative technology and excellent networking protocols, whereas HP's reputation for support and services is outstanding—the merger represents an inevitable trend in the workstation segment. The market is evolving from a proving ground for startup companies with technological savoir-faire, to a critical battleground for the Western European computing platform in the 1990s.

Digital and IBM sat out the major growth phase of the first few years and are now entering the market with aggressive pricing. The potential workstation market is enormous and can contribute significantly to a large systems company's revenues. As the competitive situation becomes more intense, it will drive down prices, putting pressure on companies less well-equipped to provide a broad base of services.

This growing interest of major equipment vendors in the workstation market further emphasises the segment's maturity. For example, Digital has introduced its first RISC-based machine, the 14-mips Decstation 3100, and later in the year introduced a low-end 10.4-mips Decstation 2100, which was clearly targeted at Sun's SPARCstation 1. Digital clearly views Sun as its major competitor and the real test of Digital's workstation success is in UNIX-based workstations. (A full discussion of UNIX is in Chapter VI.)

Digital's RISC workstations are based on chips from MIPS Computer Systems. MIPS introduced several new RISC-based machines, including an entry-level workstation, the 12-mips RS2030. This highlights another key trend: the potential for smaller companies such as MIPS to be successful in the market by virtue of their relationship with a large equipment vendor—in this instance, Digital.

Data General, another equipment vendor, announced the Aviion line, based on Motorola's 88000 RISC chip set and performing at 17 to 20 mips. IBM is still developing a low-cost 20-mips workstation for introduction in 1990. IBM's belated entry into the workstation market may prove problematic for Sun Microsystems, whose strategy has been to make workstations low-cost and mass-produced for a mass market, thus

making the SPARC architecture accepted as a standard. The danger with this strategy is that Sun might lose market share at the low end of the market to lower-cost, higher-volume PC manufacturers.

At the high end, the perception that Sun does not have a high-performance product offers companies such as HP and Digital the opportunity to exploit the high end. However, Sun does have strong products. Though it may not remain a dominant force as the market matures, INPUT believes that the company will continue to be one of the market leaders by broadening its scope as Digital, HP/Apollo and IBM become more aggressive.

Sun will have to adopt aggressive marketing strategies. The market has evolved rapidly. Though workstations were originally designed for independent users, INPUT's end-user research indicates that there is now more of a need to share resources across the corporation, resulting in opportunities for companies—such as IBM, Digital and HP/Apollo—that, with their wider product lines, are better positioned. Sun needs to aggressively target the corporate computing environment.

Not all the shifts in the workstation market in 1989 were in the corporate sector. The influx of RISC-based workstations signalled not only the long-expected fundamental shift from complex instruction set computing (CISC) to reduced instruction set computing (RISC), but also the eventual replacement of Motorola 68000-based machines. It is likely that the 68000 will disappear over the forecast period as the 386 and 486 chips compete for the parts of the technical workstation market based on cost/performance. (A fuller discussion of RISC occurs in Chapter VI.)

NeXT Inc., the company launched by Apple cofounder Steve Jobs, developed a 68030-based machine. Although it is a good, well-packaged product, INPUT does not anticipate that the NeXT machine will make a significant impact in the commercial workstation market. It does not possess anything that cannot be duplicated by other vendors and it opens no new technology windows, a key requirement in this technology-orientated market.

INPUT's end-user research indicates that a crossover of workstations from the engineering and technical to the commercial—with the exception of the manufacturing and financial sectors—has not occurred to any great extent. However, this can be partly attributed to a lack of commercial application software. In a move to accelerate this commercial crossover, in July 1989 Sun signed a deal with Lotus to develop products for workstations, which will speed workstation acceptance in a commercial environment. Both Digital and Sun cite commercial applications as a strategic goal. There are several factors in their favour:

- Imminent software availability
- Portability
- Lower prices

- Convergence of many UNIX versions to two: Open Software Foundation and UNIX International, Inc.

At the other end of the workstation spectrum, Silicon Graphics continues to dominate the high-end three-dimensional graphics niche. However, these niches are still very small; the merger between graphics supercomputer makers Ardent and Stellar Computer (the merged company is named Stardent) was a realisation that the niche wasn't big enough to support both.

In conclusion, the key issues for workstation equipment vendors can be summarised as follows:

- A shift away from mips to added features and functions
- Price no longer a key issue
- Interoperability
- Ease-of-use and support issues are important to users

INPUT concludes that though the workstation segment will experience high growth rates, there will be an inevitable shakeout of companies unable to keep pace with the two central developments:

- Standards
- Need for connectivity

B

Workstation Software Products Environment

1. Introduction

The high-performance workstation has been one of the principal driving forces in the software and services market of the 1980s. The workstation originated at Apollo Computer in 1980. Apollo introduced its Domain workstations to the technical professional at the same time that the PC was starting to revolutionise computing practices for the average office worker. In both cases the aim was the same: to free the individual from the constraints imposed by having to share facilities.

The high-performance workstation has increased as a market sector from nothing in 1980 to over \$4 billion sales worldwide in 1988 for one predominant reason:

The workstation was designed to act equally well as a standalone station or as a node in a cooperative network of processors, where the minimum power available on each desktop could be supplemented by shared resources of extra disk files, printers, terminals or other networks.

The flexibility of this approach led the workstation to encroach on the traditional preserves of the mini and the supermini in such areas as:

- CAD/CAM
- Laboratory and research applications
- Commercial applications, especially in the financial sector

2. Important Thresholds

By the time Apollo, the pioneer, was overtaken in size by Sun Microsystems, two significant thresholds had been passed, one commercial and one technical:

- The workstation sector had proven that the right price per “desktop-delivered mip (million instructions per second)” could be provided better from a series of personal workstations than from the traditional multiuser, multiprogramming minicomputer (with its costly, complex overheads notoriously hard to predict in fresh application situations).
- Sun’s espousal of the standard UNIX open operating system (at the time already known to the technical and research computing community) aided its phenomenally fast growth by allowing it to offer “future-proof” expansion capability, in contrast to the cradle-to-the-grave approach of the industry giants, with their proprietary locked-in environments.

3. Industry Drivers

A number of factors have been working within the industry over the last decade, to the extent that 1988 became the watershed year when UNIX achieved a level of publicity (or rather, notoriety) from which it can never easily fall back into unrecognised academic obscurity. These factors were:

- The open-systems concept, born of the need for easy networking, continually foundered on the rocks of the nuts and bolts of proprietary operating systems.
- Software portability has become more essential.
- The convergence of telecommunications and data processing has led national governments and new market entrants alike to promote open systems in opposition to the stranglehold of the multinational equipment suppliers.
- The advanced facilities built into UNIX over the course of time for use in demanding, high-performance applications have finally overcome the initially well-founded reservations of the commercial data processing users.

4. The Politics of UNIX

In 1988, the split in the UNIX community between the OSF (Open Software Foundation) (with vendors like IBM, Digital and Hewlett-Packard in its ranks) and UNIX International (the team led by AT&T, the owner of the UNIX software) was triggered by the supposedly favoured treatment proposed by AT&T for its new joint-venture partner, Sun. Whatever the rights and wrongs of the arguments from both camps, the sound of the battle awoke MIS management around the world to the realities of the situation:

- In 1988, UNIX-based systems accounted for between 12% and 20% of all midrange and medium/large computer systems sold in Western European markets, the actual percentage depending on the country market concerned.
- Vendors dedicated to UNIX-based systems are expanding currently at rates of 100% per annum.
- The UNIX market for products and services is expanding at between 30% and 40% per annum.

The de-facto adoption of UNIX as the prime operating system standard for open systems and the concentration of its involvement in midrange systems is having a strategic impact on the whole information systems business, due to its impact on software provision. A summary of workstation vendors' UNIX strategies is included as Exhibit III-2.

EXHIBIT III-2

Summary of Workstation Vendors' UNIX Strategies

Vendor	UNIX Position		Target Users					Target Markets			
	Primary	Secondary	Software Development	Technical	Commercial	Systems Integration	Banking & Finance	Manufacturing	Education	Government	Other
IBM Midrange		(1)			X	X	X	X		X	X
IBM Micros		X					X	X	X	X	X
Digital		X	X			X	X	X	X	X	X
Sun	X		X	X	X	X	X	X	X	X	
HP/Apollo		(1)					X	X		X	X

(1) Primary operating system in technical environments; secondary operating system in commercial environments.

All other trends created by the expected further penetration of the UNIX open-system solution stem from the fact that open systems allow for software from all sources to be ported onto potentially any hardware platform.

The Open Software Foundation (OSF) is an international organisation created to define specifications, develop software and make available an open, portable application environment. The OSF aims to address the following:

- Portability—the ability to use application software on computers from multiple vendors
- Interoperability—the ability to have computers from different vendors work together
- Scalability—the ability to use the same software environment on many classes of computers, from PCs to supercomputers

Members include: IBM, Digital, HP/Apollo, Bull, Nixdorf and Siemens.

5. Strategic Trends

Stemming from this increase in potential for portability are the following strategic trends:

- Software products will be the most important delivery mechanism for applications.
- Equipment vendors will be able to point to the increasing number of packaged portable applications that have been fully tested in the open systems market running on different platforms.
- Professional services will remain an important vehicle for delivering a total solution that consists of equipment, software and services.

6. Users' Priorities

User management is increasingly concerned with standards and integration of systems rather than specific functions. Many companies that invested heavily in computers and communications in the 1960s are now running into difficulty because of the growth of management ideologies recommending decentralisation and devolvement of responsibility. These companies' networks were built to reflect centralised organisational patterns and hierarchical management structures.

In the 1980s, distributed computing has brought much greater power to users and has complicated network management and control. Organisations have regrouped with flatter management structures, and have developed business units that demand locally held accounts and electronic information on their own systems.

7. Technology Push or Market Pull?

The central issue is whether the change has been a result of technology push or market pull. One clear result has been what could be termed "PC and network anarchy," whereby systems are increasingly acquired on an ad-hoc basis. These changes have also been manifested in purchasing attitudes. In other words, instead of computers being relatively expensive, the roles are now reversed and workstations are establishing themselves as tools to aid workers' productivity, with operators no longer in a secondary role to expensive centralised computers.

Another key factor is the pace of technological change in the personal computer and workstation markets. Though workstations currently give excellent value for the money, they become obsolete more quickly, a pattern that looks set to continue with 80486- and 80860-based machines.

For IBM users, this turnover results in costly investment decisions. For instance, the PS/2 50 is too slow for the recent OfficeVision. In the near future, there is likely to be a greater distinction between workstations and servers with client-server computing, which is likely to involve the use of UNIX as the server on the RISC-based chip. However, IBM will ignore UNIX in the office environment.

Within the next three years Fibre Distributed Data Interface local-area networks will fall in price and become the norm, and within a shorter timeframe, workstation operating systems will feature true 32-bit addressability. At this point, users will enjoy the enormous benefits of multifunction workstations.

8. Sun Microsystems

Sun's desire to outgrow Digital and become the new leader of the industry has not yet been achieved. Sun, at over \$1 billion in 1988, is still an order of magnitude less than Digital at over \$12 billion worldwide. But Sun has had an influence beyond its numeric strength because it has been delivering what users have wanted:

- Ever-cheaper, ever more powerful computing in a convenient form, easy to use and able to be integrated into a user's earlier investments in hardware and software.

Sun has promoted UNIX to a stage where it is regarded as the prime open architecture operating environment for general-purpose computing worldwide, but Sun alone has not been responsible for this.

Throughout the 1980s, Sun capitalised on its strength in the engineering workstation market by selling to dealers in the City and Wall Street, linking with UNIX licensor AT&T for future developments of UNIX, and getting its SPARC chip design accepted as a widespread standard.

Within four years of entering the workstation market, Sun was already making over \$200 million in revenues and by 1987 it had overtaken its closest rival, Apollo. Sun became the first vendor to go over the \$500 million mark, posting \$645 revenue. Apollo crept behind with \$470 million. Its eventual fate was to be acquired by Hewlett-Packard.

Sun's success was also reflected by the healthy rise in the value of the workstation market. Worth \$1.5 billion in 1986, the market grew to \$2.5 billion by the next year. By 1988 it had reached \$4.1 billion, and the same year Sun set a new milestone by becoming the first specialist workstation company to pass the \$1 billion revenue mark.

Sun chose to build computer systems around all of the current computer architecture available: Intel 80386-based systems, Motorola 680X0-

based systems and its own SPARC scalable RISC technology microprocessor.

It is with the latter of these architectures that the company has had the most success. Sun took it upon itself to create a standard in the workstation market, just as IBM did with Intel and MS-DOS, by licensing SPARC technology to other computer companies and large semiconductor firms like Toshiba and Fujitsu.

Sun's strategy for the success of its systems, however, revolves around AT&T's UNIX multiuser multitasking operating system—its version of UNIX is called Sun OS. According to Sun, it chose UNIX because it is the industry's most portable operating system, running on a broader range of computers than any other, therefore meeting the needs of virtually any customer. The company has chosen to split the market to which it sells into three user groups:

- Desktop
- Power
- Network

Sun believes that the desktop user requires a fully functional yet economical system available from any vendor. Its answer was to release the SPARCstation 1, which is capable of handling 12.5 million instructions per second (mips).

The power user and engineering and scientific fields require a high-speed computer capable of producing sophisticated 3D graphics. In this area Sun offers its SPARCstation 300 series.

The network computer, or file server, must handle all input/output-intensive computing tasks such as transaction processing, inventory control and accounting. Sun claims that its SPARCserver 300 can support disc capacities of up to 32 Gbytes, and that its Sun 3/470 is the industry's most powerful 68030-based network server.

Early in the life of the SPARC processor, Sun decided that to expand the number of SPARC-based systems around the world, and to adhere to its open systems strategy, it would be better to licence the SPARC technology to other computer companies.

In this way the company believes that SPARC will become the future workstation standard and that software houses will mass-produce off-the-shelf software—SPARC ware. Recently Sun has made several licensing agreements of the SPARC technology, most notably with Toshiba, Tatung and the Dutch electronics giant, Philips (which plans to develop its own version of the SPARC chip and to manufacture embedded controllers based on SPARC technology).

This year (1989) saw the appearance of the first clone workstation based on SPARC. Colorado-based Solbourne Computer announced a family of workstations that are binary compatible with Sun-4 workstations, the first system Sun designed around SPARC.

Problems with profitability in the past year have been cited by Sun management as a “faulty management information system.” However, Sun’s problems have rather more to do with the price-cutting pressures being imposed on it by Digital and Hewlett-Packard (now the owner of rival Apollo).

9. Digital

Digital Equipment Corporation is the second most influential vendor in the computer market-place today. The company initially developed and grew by successfully selling minicomputers to scientists and engineers, but in recent years has greatly expanded its commercial business. The key advantage Digital has achieved is the ease of networking amongst its own products and the ability to communicate with other products, especially those made by IBM. Coupled with a concentration on its main midrange VAX architecture, this ability to network has resulted in Digital’s taking the world lead in distributed data processing (DDP)—to the extent that DDP is now the accepted wisdom of the industry, a wisdom that even IBM has been forced to acknowledge and follow.

The recent trading difficulties experienced by many of its traditional rivals from the original minicomputer field (Data General, Prime, Nixdorf, Norsk Data) have led observers to speculate on the possibilities of Digital’s also running into difficulties, as the minicomputer is attacked:

- From the bottom end by the multiuser micro
- From the top by the increasing economies of scale of the mainframe
- Sideways from the high-performance workstation

All these pressures exist, but are not eliminating the middle ground of computing. What is currently happening is that the flexibility and modularity envisaged in the distributed processing concept requires a matching flexibility of solution implementation at the same time it opens a whole range of solution possibilities.

Nevertheless, Digital is going through a period of difficulty as users await the resolution of some of the questions relating to the company’s strategic directions. These questions refer mostly to the operating system strategy:

- Proprietary (VMS) or nonproprietary (UNIX/Ultrix)
- VMS functionality versus the cheapness of the UNIX commodity approach

- The question of open systems cohabiting effectively with closed systems on a single vendor platform

The extent of the software, both system and applications, that is now offered to the Digital user base means that there is no simple answer that can be speedily implemented. Digital's success in growing to a \$12 billion revenue company worldwide has expanded its user base into the boardrooms of the world during the last decade. In many ways, the company has not yet caught up with the consequences of this success:

- On-line teleprocessing (OLTP) software from Digital itself has come onstream only in the last two years
- Database managers and CASE tools from third parties are taking over Digital's own products

Digital will gain significantly in 1990, helped by its penetration of markets outside the traditional technical application areas.

The workstation market will continue to have a growth rate in excess of 50% until 1994, presenting an increasing threat to the high-end PC. With about 45% of Digital's sales in Europe, the company is now depending more on the customer's acceptance of its apparent change of strategy (i.e., the departure from VAX architecture with the launch of its first RISC workstation). This change will be a decisive factor in Digital's success as a workstation vendor.

10. Hewlett-Packard

By purchasing Apollo, HP acquired some of the most highly regarded and reliable UNIX technology available. HP acquired the greatest market share of the workstation pie, gaining not only Apollo's workstation customers but a foot in the door for customers' future purchases—workstations, PCs and multiuser systems. In fact, the workstation market is just a lever to project HP into a complete UNIX solution situation. By using UNIX, open systems and standards, HP wants to turn itself into a company on the order of IBM and Digital.

Before purchasing Apollo, HP was already in most of the markets that make up computing; what the company lacked was domination of any particular market segment. The top-end multiuser systems based on HP's own RISC technology are well-regarded; in the middle HP has the 9000 series of workstations; and its own PC, the Vectra, is selling well. If HP can establish itself as the name for workstations, the rest of the product line will benefit.

Overall, the action is going to move over the forecast period from workstations to the replacement of multiuser minis, micros and network

servers. That's why UNIX is going to be such a hit in the future as a replacement for IBM System 36s and the like.

HP is overhauling its distribution strategy following the Apollo acquisition since the number of European-authorized HP workstation distributors has quadrupled. HP marketing management says that authorized suppliers will be split into straight distributors and value-added resellers, and the number reduced.

For example, Apollo distributor Compel will become a VAR and another distributor, Mancos, will become a rental company. Existing HP workstation distributors, such as Perrin Systems and Protek, have taken on the Apollo range, and Apollo distributors such as Hawke Systems and BIC Systems are negotiating agreements with HP. Inevitably, some PC dealers that want to move up to workstations, and other VARs may be interested. HP does not have a definite figure on the number of distributors it wants.

Although many VARs and distributors claim to be happy with the additional product range, there is likely to be a shakeout among the enlarged group's 400 or so European resellers. HP's policy of selling integrated systems, particularly in the CAD/CAM area, is bound to affect certain software companies.

11. IBM

If one looks at IBM's strategy in the context of technology push or market pull—for example, with products like NetView (a centralized management tool)—it is apparent why IBM seems to be denying the call for more intelligence in workstations. Furthermore, with the growth of X.25—ideal for a workstation networking environment and for strategic wide-area network management—IBM is in a difficult position if it wishes to be a major network management supplier in the 1990s.

Due to IBM's lack of presence in the European workstation market, it is instructive to look at its U.S. activities: in 1988, IBM formed its Advanced Workstation Division, which is devoted to AIX software and hardware. This division is responsible for the new IBM workstations, which will run the same version of AIX as PS/2.

In the past, IBM has always provided proprietary operating systems for its machines. The one exception was MS-DOS, the first operating system used on IBM PCs. With AIX, IBM is going halfway—AIX will run only on IBM equipment, but will run standard applications without the need for recompiling.

The most interesting aspect of the AIX release is its windowing system, the first IBM release of X Windows. IBM X Windows uses a bit-

mapped screen and proprietary mouse-driven operating system, enabling the user to open several windows at a time, each with its own UNIX shell or virtual DOS machine, providing there is a DOS facility. For connoisseurs of desktop environments, IBM windows is close in feel to Sun/AT&T Open Desk-top. All versions of AIX are sold as separate components: the base operating system (runtime system), a software development system, a text-processing system and a DOS facility.

Since early 1989, IBM has been working with software developers to port applications to AIX. Overall, IBM is doing an excellent job enlisting third-party support. No specific numbers have been quoted, but is probably running at about 500 applications, with more graphics workstation applications than either 386/ix or XENIX.

IBM AIX PS/2 is a well-designed UNIX system and a logical extension to the AIX range, possessing excellent documentation, portability to other systems and the graphics facilities to succeed as a UNIX workstation.

There are those who consider IBM's entry into the UNIX business a spoiling tactic: create sufficient confusion in the business of UNIX standards and the users will turn back to IBM's proprietary system. Looking at IBM's investment in this area, this seems unlikely. IBM's AIX research and development team numbers 2,500—more people than were used for the launch of the PS/2. Include the marketing, support and service people and you have 10,000+.

The other factor in favour of IBM's UNIX is the obvious commitment the company has made to standards organisations. IBM is a member of all the key committees of the American Institute of Electrical and Electronic Engineers, which defines the portability issue of UNIX. IBM is also a member of X/Open—this release of UNIX for the PS/2 conforms to X/Open standard issue 3. Finally, IBM is one of the founder members of the Open Systems Foundation (OSF), the most influential body in UNIX.

However, three key factors should be borne in mind when considering the European situation:

- IBM's new RISC systems will be targeting a market whose start-up growth phase has already passed and which is already beginning to mature.
- Eroding Sun's embedded base is a difficult proposition for IBM, and decelerating growth in this market-place could be expected to constrain IBM's ability to increase revenues.
- IBM RT sales in 1988 were \$115 million. However, no more than 16% were for engineering and scientific installations. The remainder were divided between large-account commercial applications and small/medium business users.

AIX (Advanced Interactive Executive) is IBM's UNIX-based operating system for System/370 Architecture Processors (9370 to 3090 range), the 6150 Micro and the Intel 80386-based Personal System/2s. AIX is derived from the UNIX System V source from AT&T, together with many generally available enhancements—notably features of System V.2 and many from the bsd (Berkeley Software Distribution) 4.2 and 4.3.

12. Bull

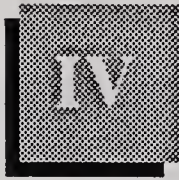
Bull's worldwide series of product announcements has been viewed as an indication of its readiness for the Single European Market. These announcements revealed eight new models in the DPS 7000 range; the availability of Oracle under GCOS 8 for the DPS 8000, DPS 90 and DPS 9000 models; a package to link micros and mainframes; the DPS 6 Plus minicomputer office system and communications packages (based on Open Systems Network Architecture); and the Bull Micral 600 micro, running under MS-DOS or UNIX with the 25 MHz 80386 Intel processor.

Bull also announced the OSI/DSA offering, giving clients electronic mail, distributed relational databases, transactional processing and network management. Open systems fit in with Bull's philosophy; common hardware gives the company the ability to bring its open market strategy to the Single European market, where it focuses on the provision of software for niche markets.



Market Analysis and Forecast





Market Analysis and Forecast

The objectives of this chapter are to:

- Categorise the software products market in terms of the different classes of software and the different hardware platforms
- Set the revenue stream in context with the overall software and services market in Western Europe
- Produce a Western European market sizing for workstation software

A

Market Definition

INPUT's schematic representation of the total software products market is given in Exhibit IV-1. This exhibit shows the constituents of the system and application software subsectors.

EXHIBIT IV-1

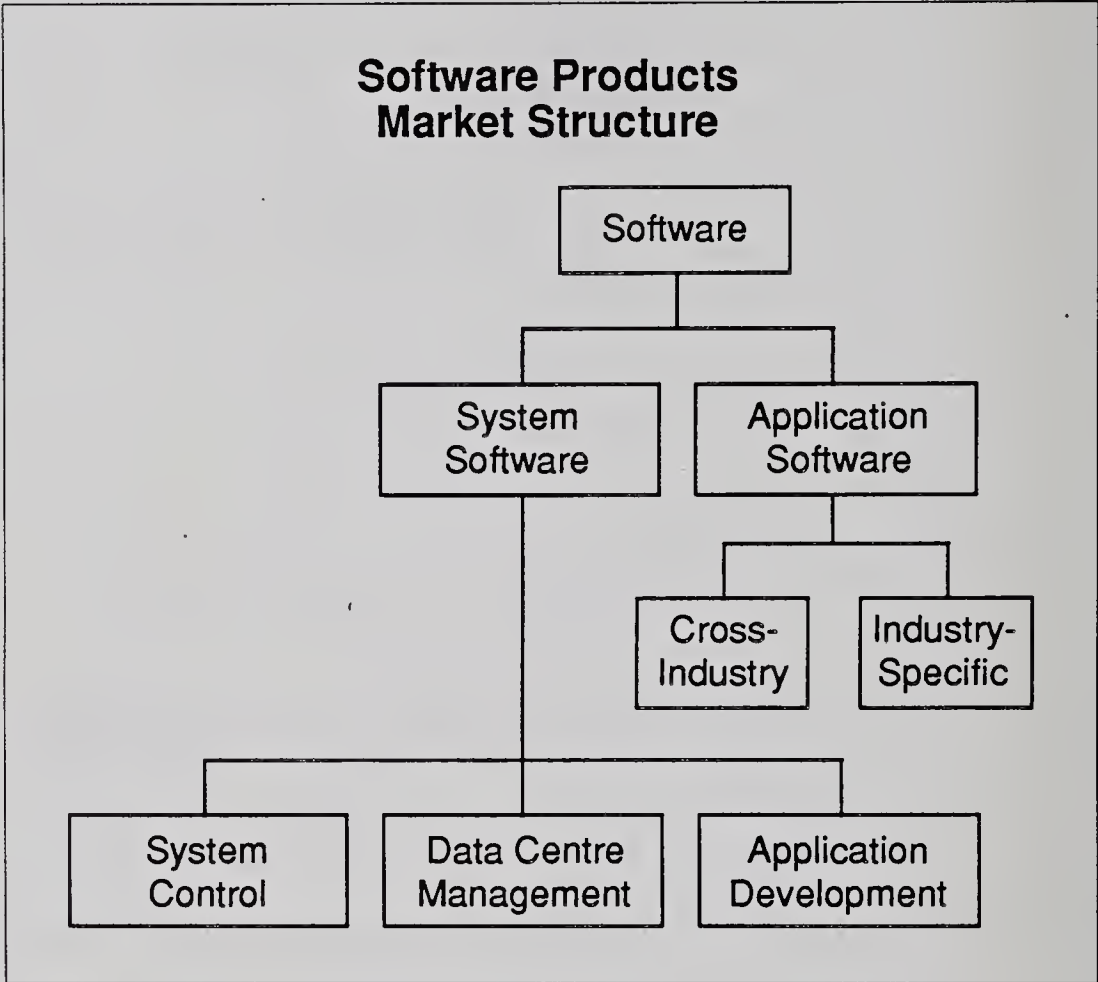


Exhibit IV-2 shows the system software portion further structured into three main areas: system control, data centre management and application development. Each of these areas is further described in terms of specific functions.

EXHIBIT IV-2

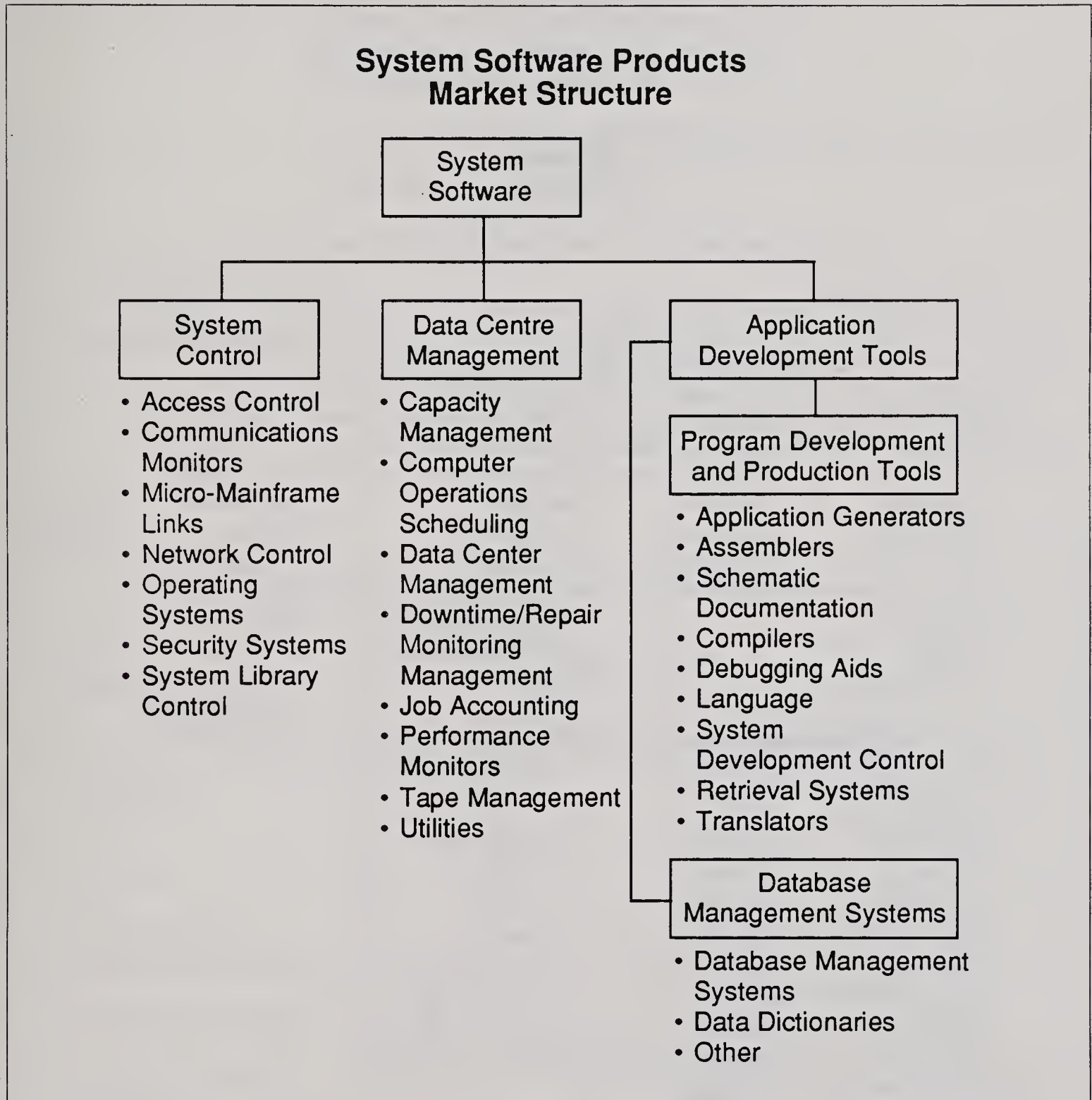


Exhibit IV-3 shows the application software portion structured into two main areas: cross-industry and industry-specific. Each of these areas in turn is broken down into sectors.

EXHIBIT IV-3



Though this study is mainly concerned with workstation application software, system software is also discussed as it directly affects the evolution of the workstation market as a whole.

Application software products are defined as follows:

- Software that performs a specific function directly related to solving a business or organisational need. Application software provides information directly to the end user.

Appendix A contains INPUT's detailed definitions.

Exhibit IV-4 illustrates a layered approach to categorising software products. Its tabular form shows the different layers of standard software now required for most general-purpose systems. Though the application sector is relatively evenly split between mainframe, midrange and the desktop computers, the bias in systems software is towards the mainframe, the inclusion of databases and generic business applications such as spreadsheets and word processing.

EXHIBIT IV-4

Definitional Map of Software Classes

Category of Software	Type of Platform			
	Mainframe	Midrange	Workstation	PC/Micro
Operating System	S	S	S	S
Utilities	S	S	S	S
Languages & Development Tools	S	S	S	S
Database Products	S	S	S	A
Business Software	A	A	A	A
Application Packages	A	A	A	A
Other (e.g., Bespoke)	A or S	A or S	A or S	A or S

↑

Generic Software

←

Germane Software

↓

Key: S Indicates System Software

A Indicates Application Software

B**Forecast Definition**

The market assessment and forecast growth were developed from evaluation of current and projected activities within the market definition described above. Forecasts for the total software products market and workstation system software are also included to provide vendors with a means of comparison.

The forecasts cover the period 1988 to 1994 and assess end-user expenditures. Forecasts are made in local currencies and converted into U.S. dollars for aggregation and comparative purposes.

Owing to the volatility of international exchange rates, the U.S. dollar conversion rates have been taken as the rate on December 1, 1989. Exhibit IV-5 sets out the average U.S. dollar exchange rates on December 1, 1989 for the range of Western European currencies and the inflation assumptions made.

EXHIBIT IV-5

U.S. Dollar Average Exchange Rates

Country	Currency	Dollar Exchange Rate	Inflation Assumptions
Austria	Sch	13.60	+2.8
Belgium	BF	40.50	+3.0
Denmark	DK	7.53	+4.8
Finland	FM	4.32	+6.0
France	FF	6.55	+3.5
Italy	Lit	1,409.00	+6.5
Netherlands	Dfl	2.18	+1.1
Norway	NK	7.00	+4.5
Spain	Pta	121.00	+6.3
Sweden	SK	6.55	+7.0
Switzerland	SF	1.70	+3.0
U.K.	£	0.61	+7.7
West Germany	DM	1.93	+3.0

Source: Exchange rates—IMF (average rates for second quarter 1989)

Inflation—Barclays Bank (August 1989)

C

Software Products
Market Environment

Exhibit IV-6 defines the scope of the software and services industry that is tracked and analysed by INPUT. There are six major delivery modes: processing services, network services, professional services, systems integration, turnkey systems and software products.

Exhibit IV-7 gives relative market shares of the six major delivery modes as tracked by INPUT; as can be seen, software products and professional services account for 59% of the market.

Exhibit IV-8 shows the increasing convergence of data processing and telecommunications. The permeation of intelligence into networks of distributed and central systems means an increasing flow of software, in product and embedded forms, into the telecommunications sector.

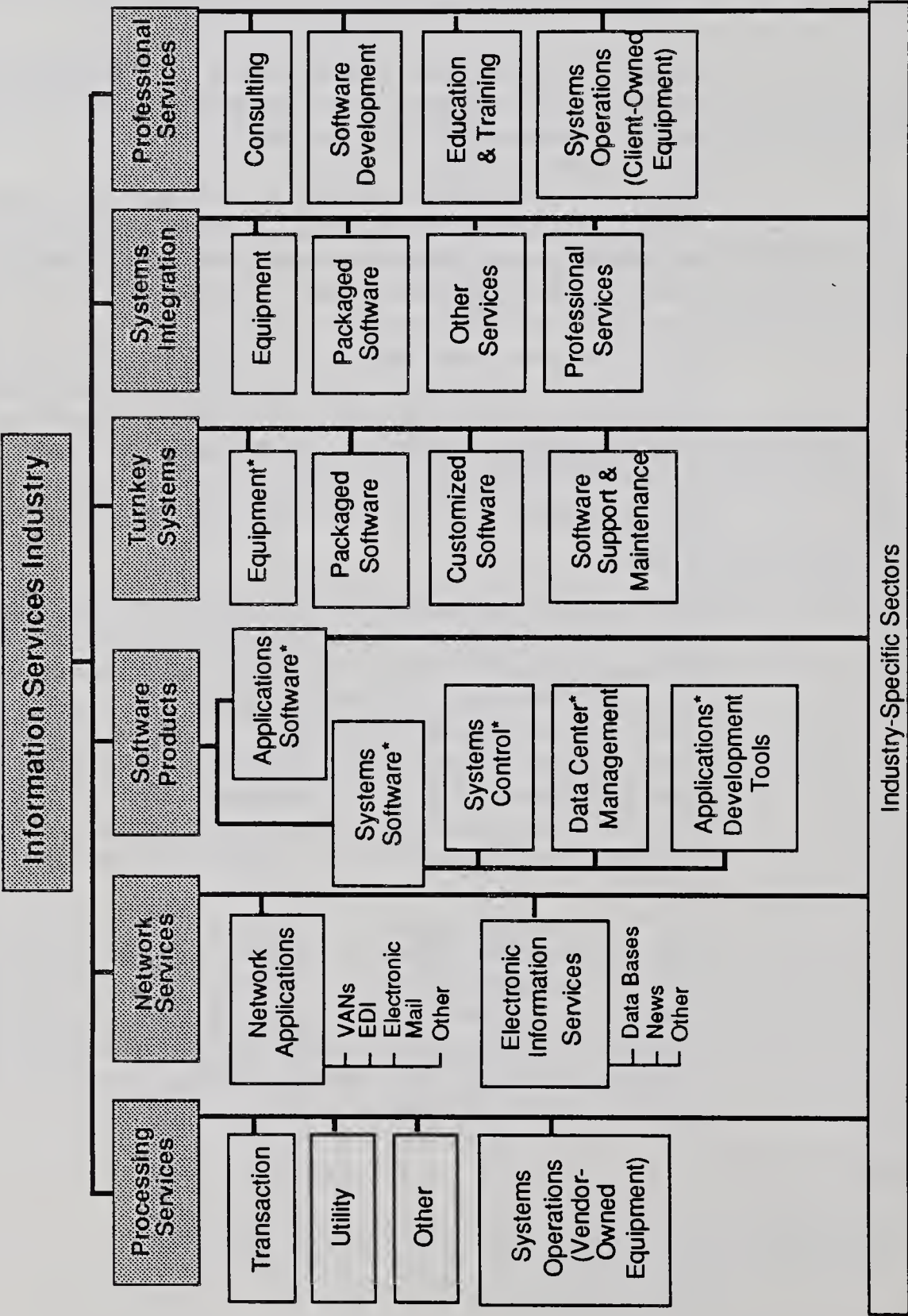
In the computer sector, software and services together already outweigh equipment expenditures by approximately 55:45. In the telecommunications sector, services (dominated by leased-line charges) and call charges outweigh equipment to an even greater degree—8:2. In the overlap between the two sectors, the data communications segment is still relatively small at \$14 billion, and is split in favour of equipment in a ratio of 6:4.

The integration of voice and image into corporate and public networks over the next five years will fuel the requirement for further standard software products to drive the systems and to implement standard business applications in cooperative processing environments. Products will increasingly be required to operate in open systems environments and the spread of these environments (even when hosted within proprietary operating systems, e.g., AIX running under VM, or ULTRIX under VMS) will encourage software authors to build products for the larger installed base of users available in the open systems market.

Hardware suppliers are already offering catalogues of several hundred products out of the 1,000 or so currently available under UNIX. Some new entrants to the UNIX equipment market do not see a need to provide specific applications products, once the basic requirements for a choice of DBMS and good business software for office applications have been satisfied. The larger, more complex applications are increasingly the province of the independent supplier.

EXHIBIT IV-6

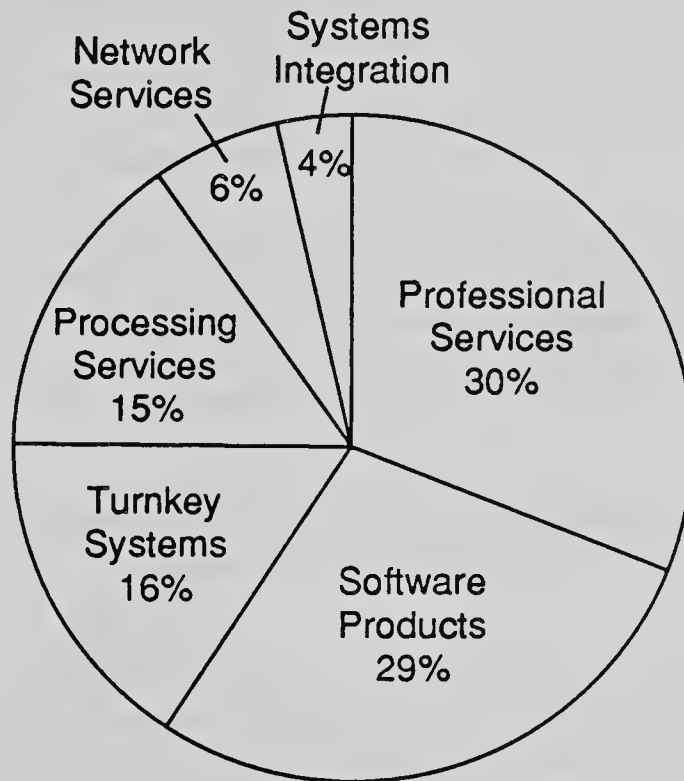
Information Services Industry Structure—1989



Source: INPUT

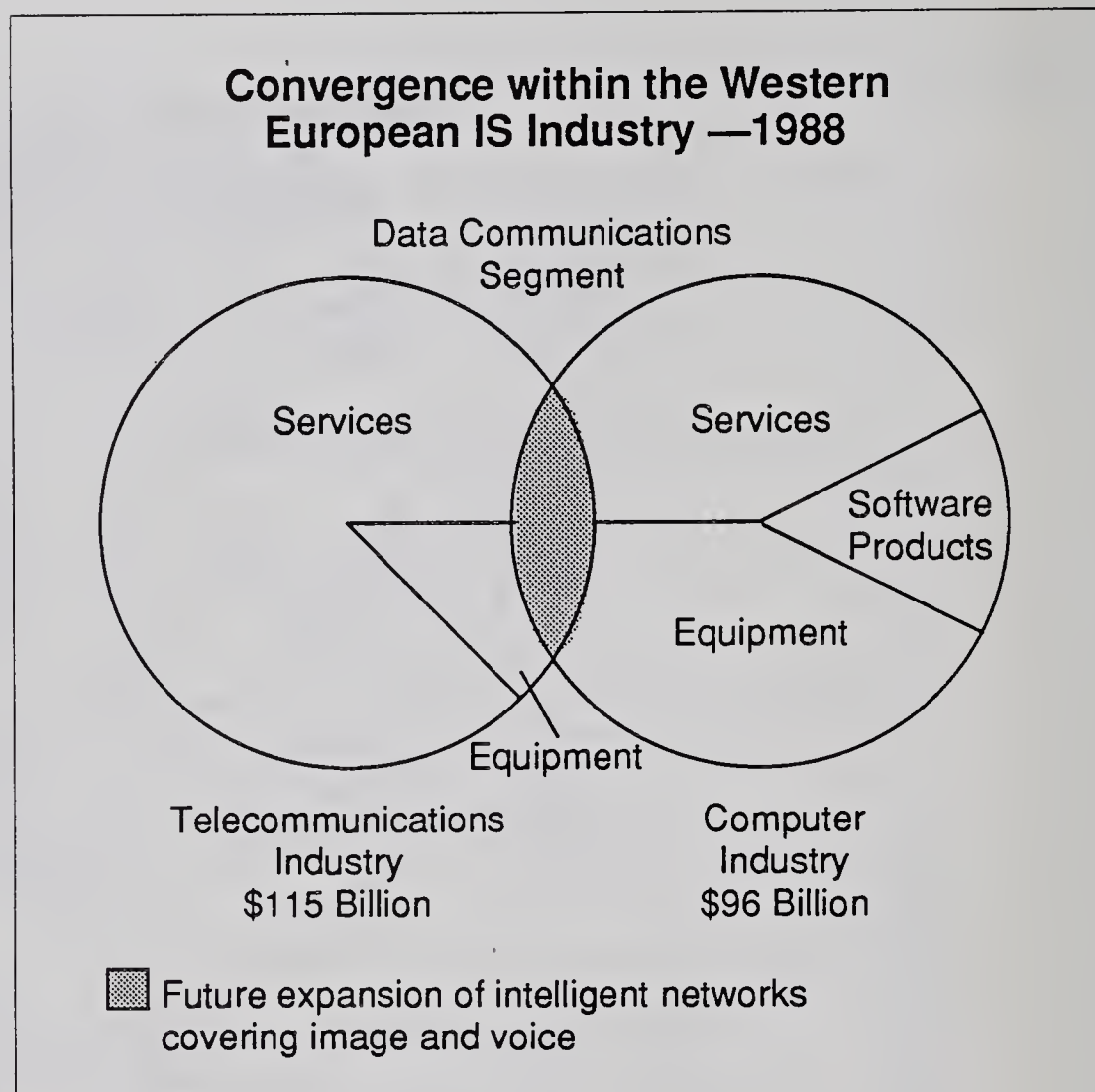
*Broken out by Workstation/PC, Minicomputer, and Mainframe segments

EXHIBIT IV-7

**Software and Services Market
by Delivery Mode
Western Europe, 1989**

Total Market = \$50.09 Billion

EXHIBIT IV-8



1. Workstation Market

One of the most critical factors in selecting an engineering workstation is application performance, which depends on CPU input/output, operating system software and graphics. Balancing these components is essential in achieving maximum machine performance. As a result, engineering organisations accessing workstations should not limit their comparisons to a single specification such as mips. Instead they should look for a balanced architecture, especially between general-purpose and graphics processing.

The ideal mix of components varies with the application. For example, visualisation requires a high number of graphic instructions. A workstation's CPU rating alone may not represent the actual performance in these applications. CPU ratings would, in this instance, be more indicative of expected applications performance when processing simulations; exhaustive analysis would involve an enormous amount of computational calculation.

Powerful engineering workstations will be required to process the increasing complexity and sophistication of engineering applications. Many of these tasks involve extensive graphics processing designed to increase productivity through pictures, menus and other elaborate functions. Human interface mips (ease-of-use, graphics) will become the most important element in computing in the next decade. A dramatic increase in human interface mips usage is forecast within the PC market. Workstation graphics are 4-5 years more advanced than PC graphics, so workstations must address human interface processing for engineering departments to realise significant productivity gains.

Higher performance in an engineering workstation translates to shorter response times; productivity increases exponentially when response times drop below one second. Typically, the faster the computer, the shorter the response time. With large and complex graphics, so many instructions are required that this slows response times.

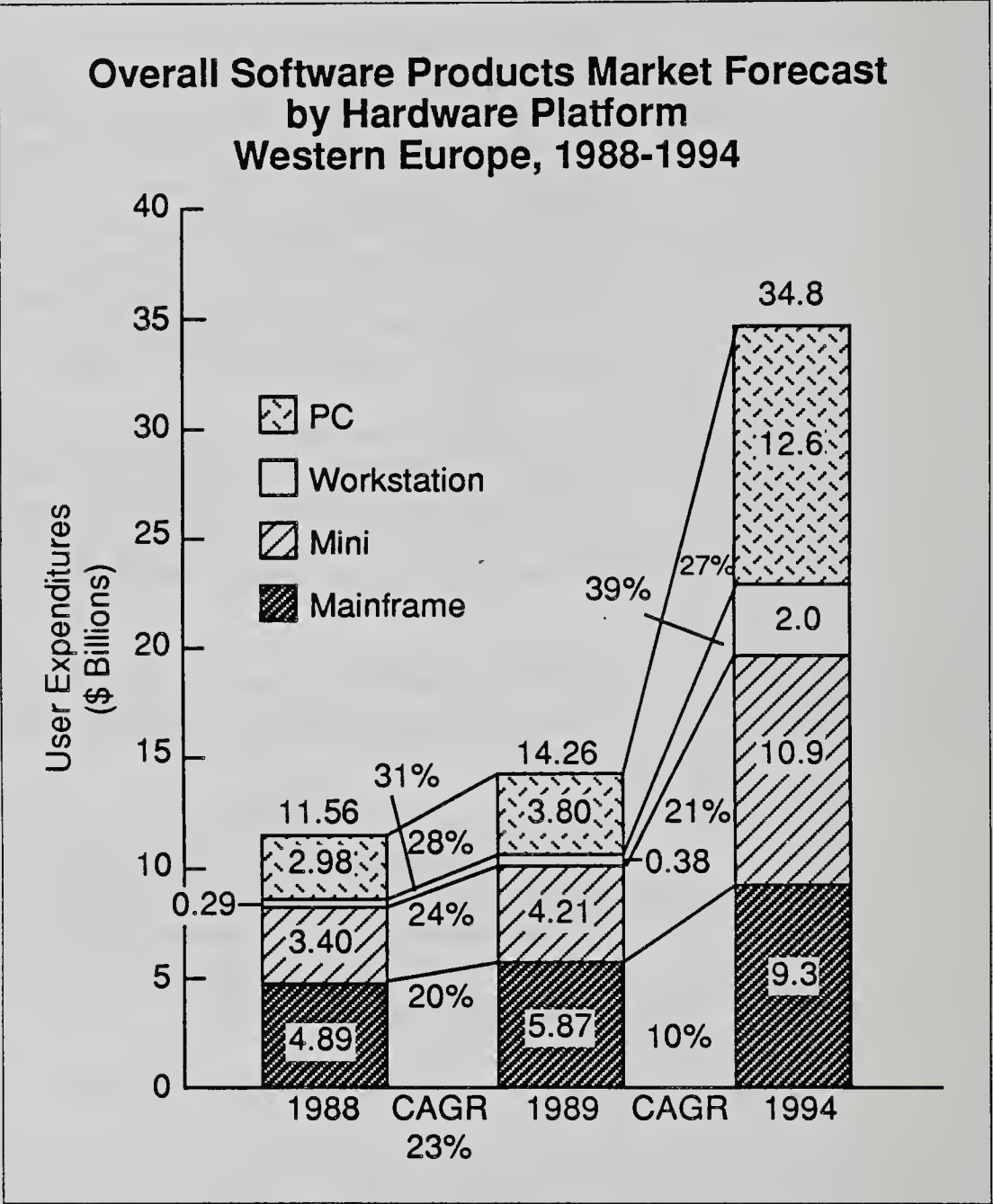
D

Overall Software Market Forecast

INPUT divides the applications and systems software markets into four major hardware platforms: mainframes, minicomputers, PCs and workstations.

As indicated in Exhibit IV-9, INPUT estimates that the combined application and system software markets will expand from \$14.3 billion in 1989 to \$34.8 billion in 1994 for a compound annual growth rate (CAGR) of 19%. This represents a higher growth rate than INPUT's projections of 19% growth for the computer software and services market during the comparable period.

EXHIBIT IV-9

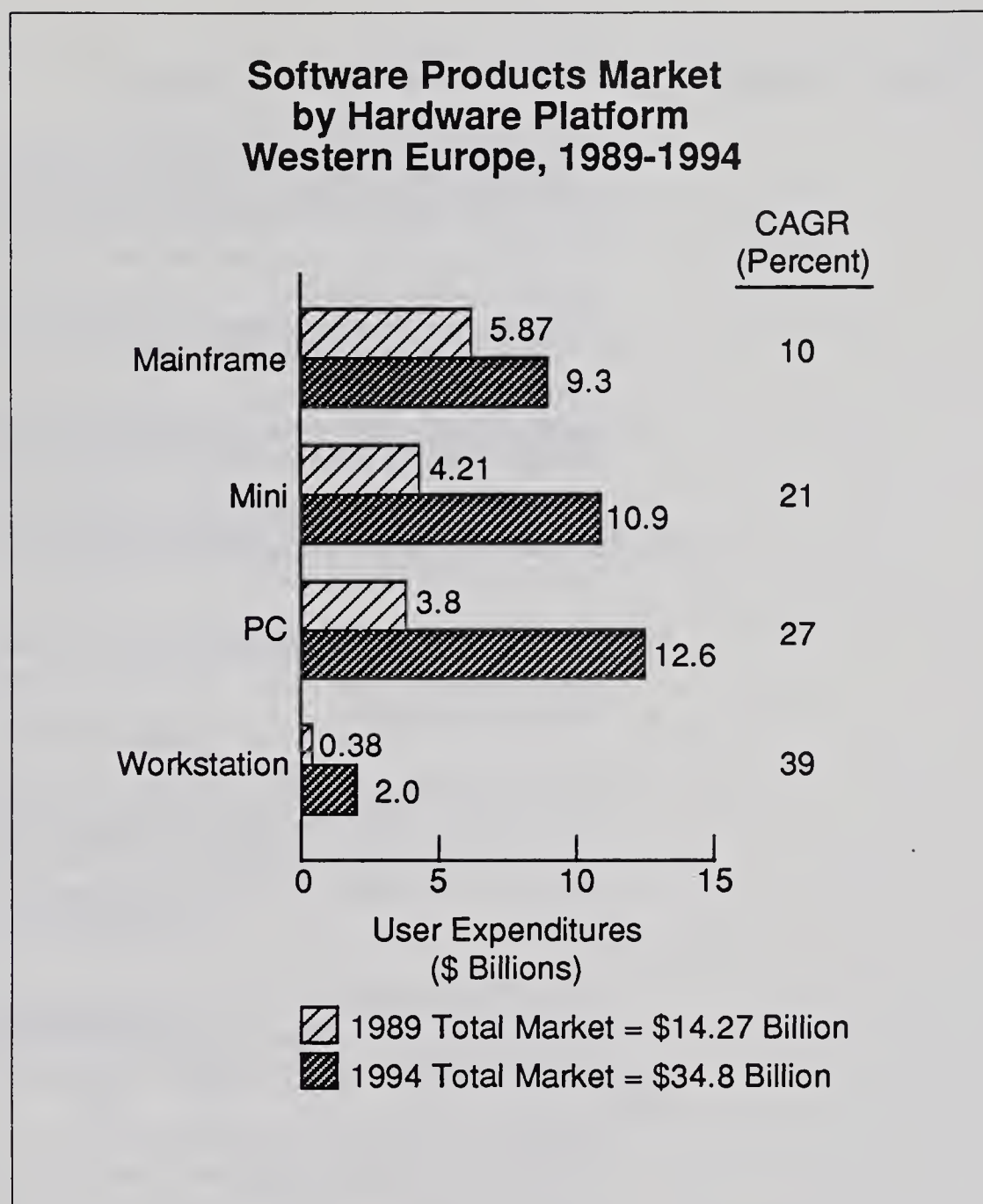


E
**Workstation Software
Market Forecast**

The strongest growth will come from the workstation software sector, reflecting the strong trend in computer processing towards distributed solutions (see Exhibit IV-10). These solutions are high-performance desktop and desktide workstations often used for technical and engineering computer-intensive applications, and increasingly run (as a result of Sun Microsystems' sector leadership) under the UNIX operating system.

Workstation software sales are projected to increase from \$0.38 billion in 1989 to \$2 billion in 1994, for a CAGR of 39%. The slower compound annual growth rate projections of 21% for minicomputer software and 10% for mainframe software reflect INPUT's lower growth rate expectations for minicomputer and mainframe platform shipments than for workstations over the next five years.

EXHIBIT IV-10



INPUT is projecting a 10% compound annual growth rate in mainframe computer shipments over the next five years and 21% compound annual growth in minicomputers during the same period. The market for workstation and high-end desktop PC platforms is projected to expand at an annualised rate of 39%, and the general personal computer is expected to grow at an approximate 27% compound annual rate. The major growth in the workstation and PC hardware platforms is projected to be for client/server network implementations.

Other factors contributing to this growth include cost/performance attributes of workstations versus the minicomputer and mainframe environments, and a transference of application development tools from minis and mainframes to workstations. More application development is being planned for the microcomputer environment.

F

Country Markets

1. Market Overview and Structure

The software industry in general and the applications sector in particular is extremely fragmented, due to the multitude of applications that exist and the varied requirements of users in different countries. With different languages, local laws and regulations and accounting systems, vendors are forced to adapt their products as well as their sales and marketing approaches if they wish to sell into foreign markets.

Looking at the applications software market Europewide, there are few vendors that are strong in all countries. Only the major hardware manufacturers such as IBM and Digital could claim to have a strong overall presence, but in many cases they are providing application software developed by other companies. Significantly, neither of these two companies is strong in the workstation application software market.

The main U.S. independent software companies all have Europewide operations and a few have a very strong overall position—notably Lotus, Microsoft and MSA.

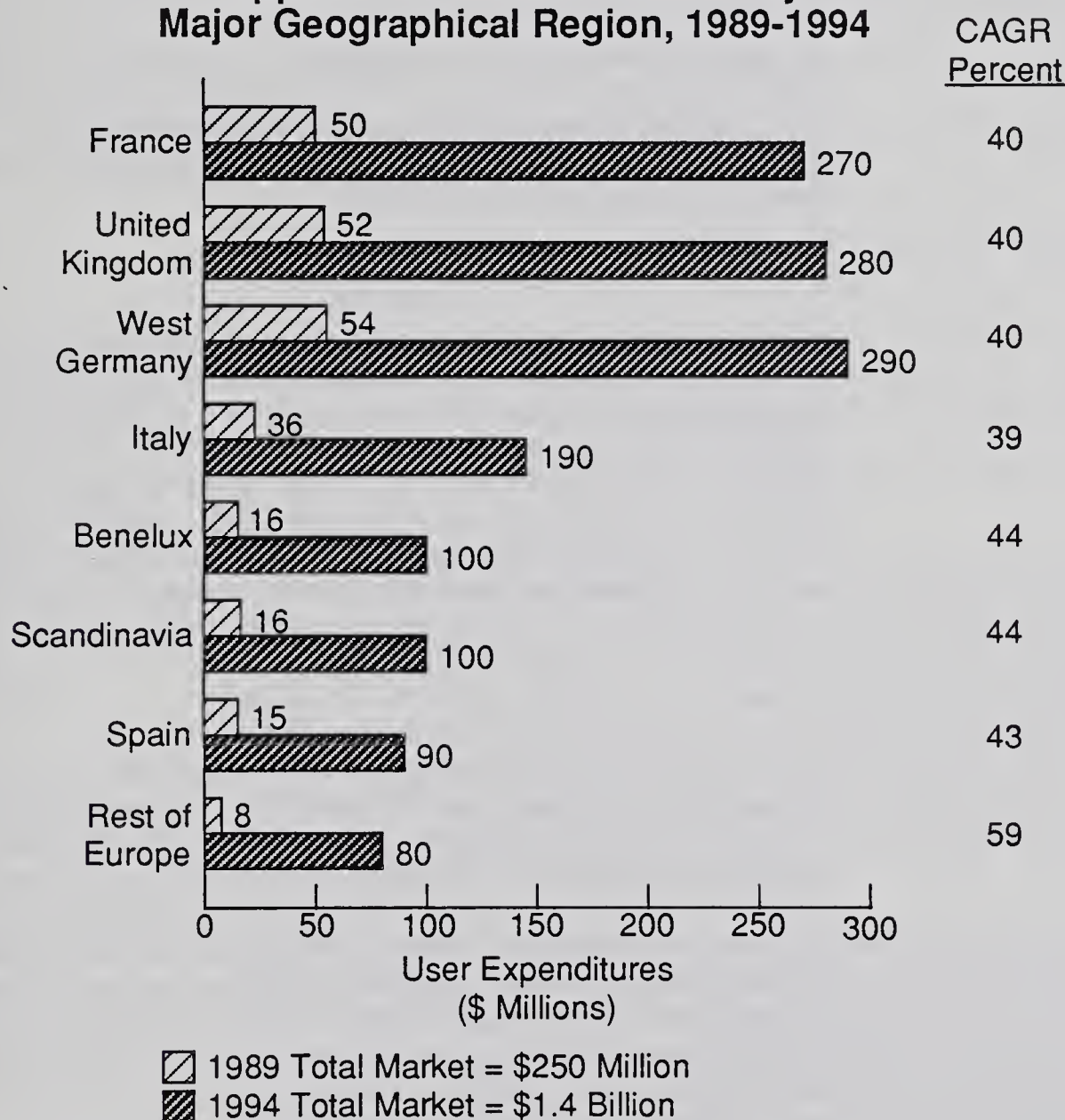
When examining the individual country markets, it is also evident that there are no dominant vendors. This is because there are so many application areas and most companies concentrate on a specific type of application. Companies are typically local and mainly confined to their own country.

INPUT distinguishes three main types of vendor organisations in the Western European market: independent European-owned vendors, independent U.S.-owned vendors and equipment vendors.

Exhibit IV-11 gives INPUT's breakdown of the workstation application market by principal market, and shows the dominance of the four major country markets—France, the U.K., West Germany, and Italy. Because of the pan-European nature of the workstation market and the predominance of U.S. companies, INPUT considers the installed base and competitive developments in the four principal markets.

EXHIBIT IV-11

Western European Application Software Market by Major Geographical Region, 1989-1994



2. France

The French installed base of UNIX systems totalled over 50,000 at the end of 1989, representing 250,000 terminals worth \$835 million, as shown in Exhibit IV-12. Market leaders were Bull with 17% of the market; Sun with 15%; Hewlett-Packard and Apollo with 14%; Altos with 8%; SMH SA, Olivetti-Logabox and IBM all with 5%; and Matra Datasystèmes, Texas Instruments, Cetai SA and—surprisingly—Digital, all with 4%. Unisys and NCR are not making the impact in France that they are elsewhere. By value, UNIX systems are anticipated by INPUT to show a CAGR of 14% over the forecast period.

3. United Kingdom

The U.K. installed base of UNIX systems also passed 50,000 in 1989 and is slightly larger than the French market, although not by much. The total figure was close to 55,000 at the end of 1988, representing 275,000 terminals worth \$910 million, as shown in Exhibit IV-12. Market leaders were Sun with 19%, Hewlett-Packard/Apollo with 16%, Altos with 11%, Digital with 10%, Unisys with 8%, NCR with 6% and IBM with 5%. The U.K. growth of UNIX systems represents a significant opportunity for vendors: 13% over the forecast period, with growth particularly strong in the first years of the 1990s.

4. West Germany

West Germany has the largest installed base of UNIX systems in Western Europe, with 60,000 at the end of 1988. This base represented 300,000 terminals worth \$1 billion, as is shown in Exhibit IV-12. Market leaders were Hewlett-Packard/Apollo with 18%, Sun with 12%, Nixdorf with 10%, Altos with 7%, Digital with 5%, Olivetti-Logabox with 4%, IBM with 3.5%, and Texas with 2.5%. The West German market is a strong UNIX market and there are considerable opportunities available as Germany seeks to become the dominant European manufacturing centre.

5. Italy

The Italian installed base of UNIX systems was 25,000 in 1989, representing 125,000 terminals worth \$400 million, as shown in Exhibit IV-12. Market leaders were Olivetti-Logabox with 12%, Sun with 12%, Hewlett-Packard/Apollo with 10%, Bull with 9%, Altos with 6%, Digital with 4% and IBM with 3%. The significantly low positions of the two major equipment vendors, IBM and Digital, and their stated commitment to UNIX mean that the next two years will prove extremely challenging for companies like Sun and Olivetti who have established a lead in certain markets. The Italian market is expected to have a CAGR of 15% during the forecast period.

EXHIBIT IV-12

UNIX Systems Market by Value

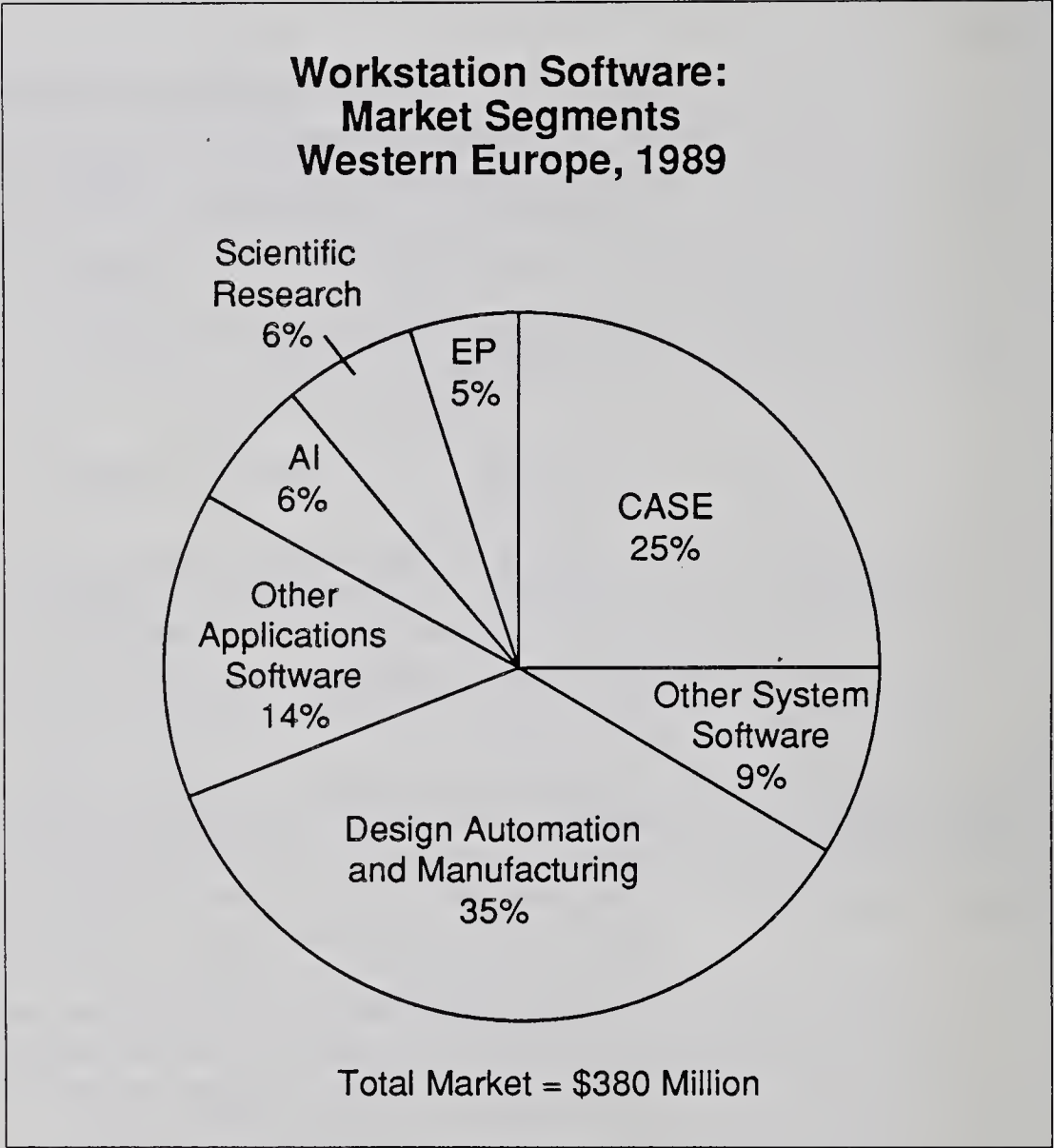
Country	1988 (\$ Millions)	1989 (\$ Millions)	CAGR (Percent)	1994 (\$ Millions)
France	750	835	14	1,600
United Kingdom	820	910	13	1,650
West Germany	900	1,000	13	1,850
Italy	360	400	15	800

G**Workstation
Software: Competitive
Environment**

Exhibit IV-13 shows the workstation application software products sectors. In the key area of design automation and manufacturing and, more specifically, in the mechanical CAD (computer-aided design) sector, all vendors are U.S.-based. Autodesk, with Autocad, dominates the PC market and is moving aggressively into the workstation market. INPUT estimates that Autocad has 70% of the U.K. market and 40% of the West German market. It also has operations in Italy, France and the Netherlands. Autocad's European revenues are \$50 million, and its PC CAD package is growing at 60% a year.

Other key vendors in this market include Prime/Computervision, a Sun OEM (approximately 50% of Sun's business is done through OEMs); SDRC, with its powerful solid-modelling package; Cimeline, PDA, with its powerful Patran package (used in the automotive industry for structural analysis); MCS with Anvill 5000 (which British Aerospace uses on VAX systems); CADAM; and the largest vendor in France, Euclid. In West Germany, the best-selling German CAD system, PC-DRAFT, now has over 7,500 installations throughout Europe. PC-DRAFT's traditional strength lies in mechanical engineering and technical documentation applications. This pan-European product appeal will be increasingly common in niche markets.

EXHIBIT IV-13



There has been much strategic activity in electronic CAD as workstation vendors look to software companies for product development. A list of relationships between these vendors is included in Exhibit IV-14. INPUT estimates that 50% of ECAD sales are in France and West Germany. Leading vendors are Racal Redac, Valid Logic, and Cadence, a fast-growing company that has introduced a product called Framework that embraces all aspects of ECAD and has consequently been successful in many target areas.

EXHIBIT IV-14

Relationship between Workstation and EDA Software Vendors

Workstation Vendor	EDA Software Vendor	EDA SMES	1989 Workstation Shipments
HP/Apollo	<ul style="list-style-type: none"> • Mentor Graphics • Racal Redac 	<ul style="list-style-type: none"> • Mentor Graphics • Racal Redac • HP 	8,377 2,466
Sun	<ul style="list-style-type: none"> • Daisy • Valid Logic • Racal Redac • Computer Vision 	<ul style="list-style-type: none"> • Daisy • Valid Logic • Racal Redac 	3,792
Digital	<ul style="list-style-type: none"> • Valid Logic • Racal Redac • Calay • Scientific Calculations 	<ul style="list-style-type: none"> • Valid Logic • Racal Redac 	1,605
IBM		<ul style="list-style-type: none"> • IBM 	29

Daisix—the merger of two leading software companies, Daisy and Cadnetix, in 1988—is an indication of the trend in this most developed of the workstation markets: there are fewer specialised vendors, and much merger and acquisition activity. (The issue of M&A is discussed more fully in Chapter VII.)

One example illustrates the importance that large equipment vendors attach to working with independent software companies in order to gain market share: HP/Apollo recently increased its suite of database management systems with a marketing agreement with complex processing specialist InterBase Software Corporation. InterBase applications on Apollo computers include data acquisition and analysis, process control and monitoring, multiuser networked systems, CASE systems and financial trading applications. Significantly, InterBase software has more than 1,350 licenses in industries—including aerospace, electronics, financial trading and manufacturing.

The crossover between the well-developed design automation and manufacturing sector will be accelerated by the rapid take-up of the X Windows standard, allied with product development agreements between equipment vendors and independent software companies. Hewlett-Packard for example, sells Frame Technology's UNIX-based workstation publishing software for engineering and design documentation, as well as view-only documentation for the manufacturing floor. In addition, HP/Apollo will market and distribute the Interleaf Core publishing software on its workstations.

Even agreements between two large vendors are not uncommon in this sector: McDonnell Douglas Manufacturing and Engineering Systems has become a VAR of Hewlett-Packard's electronic CAE/CAD solutions. McDonnell Douglas remarkets Hewlett-Packard's electronic design automation solutions on HP9000 workstations in conjunction with the UNIGRAPHICS CAE/CAD/CAM software, through the worldwide McDonnell Douglas salesforce.

Software company CADAM, supplier of the world's most widely used CAD/CAM/CAE software, recently introduced its latest release of UNIX-based Professional CADAM Interactive Solids Design (ISD). This product provides engineers and designers with new tools to reduce design and manufacturing costs while improving overall product quality and showing that independent software companies are still in the lead.

Software companies are also aggressively seeking product and marketing agreements. Sybase, a database software specialist (though smaller than the relational database giants Oracle and DTI), has sought key alliances with equipment vendors. Sybase's success in agreeing with IBM to port Sybase to the forthcoming RT RISC workstations is an indication of the naturalness of the alliance. Sybase's traditional strength in financial services will enable IBM to target one of Sun's key markets. Though INPUT does not anticipate that IBM's RT will affect Sun's position severely, Sybase's being able to add AIX to its Sun, Stratus, Pyramid, OS/2 and VAX hardware platforms is an important differentiator.

Sybase's success (the company is the fastest-growing software company in the U.S. after Ashton-Tate—its revenues were \$11 million in 1987, \$40 million in 1988 and \$3,506 million [planned] for 1989) is a result of astute strategic positioning. Sybase has firmly positioned itself in the workstation sector, avoiding the more catholic policies of Oracle. In addition to its agreement with IBM, Sybase has signed important agreements with AT&T and NeXT; Sybase is now the standard RDBMS for the NeXT box, for example.

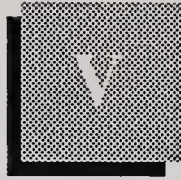
Critically, the Sybase product is specifically adapted for networked workstation applications, and the vendor will move into any areas where such configurations become popular rather than attempting to adapt Sybase for completely new environments, as Oracle did.

Oracle's product strategy for the 1990s is to shift emphasis away from specialist products to general systems. It recently announced new or upgraded applications based on its RDBMS in the CIM, personnel and accountancy fields. Oracle seeks to offer flexible applications that run in distributed environments. The new products consist of updated versions of the human resource software (Oracle Personnel and Oracle Payroll), a new version of the accounting software (Oracle Financials and Oracle Inventory) and a family of CIM products.



Workstation Software Market Opportunities





Workstation Software Market Opportunities

A

Application Software

Application software consists of two main categories: industry-specific (vertical markets) and cross-industry. Industry-specific software addresses the functional needs of particular industries, such as discrete manufacturing with MRPII solutions or insurance with underwriting analysis, policy management and claims adjustment software packages.

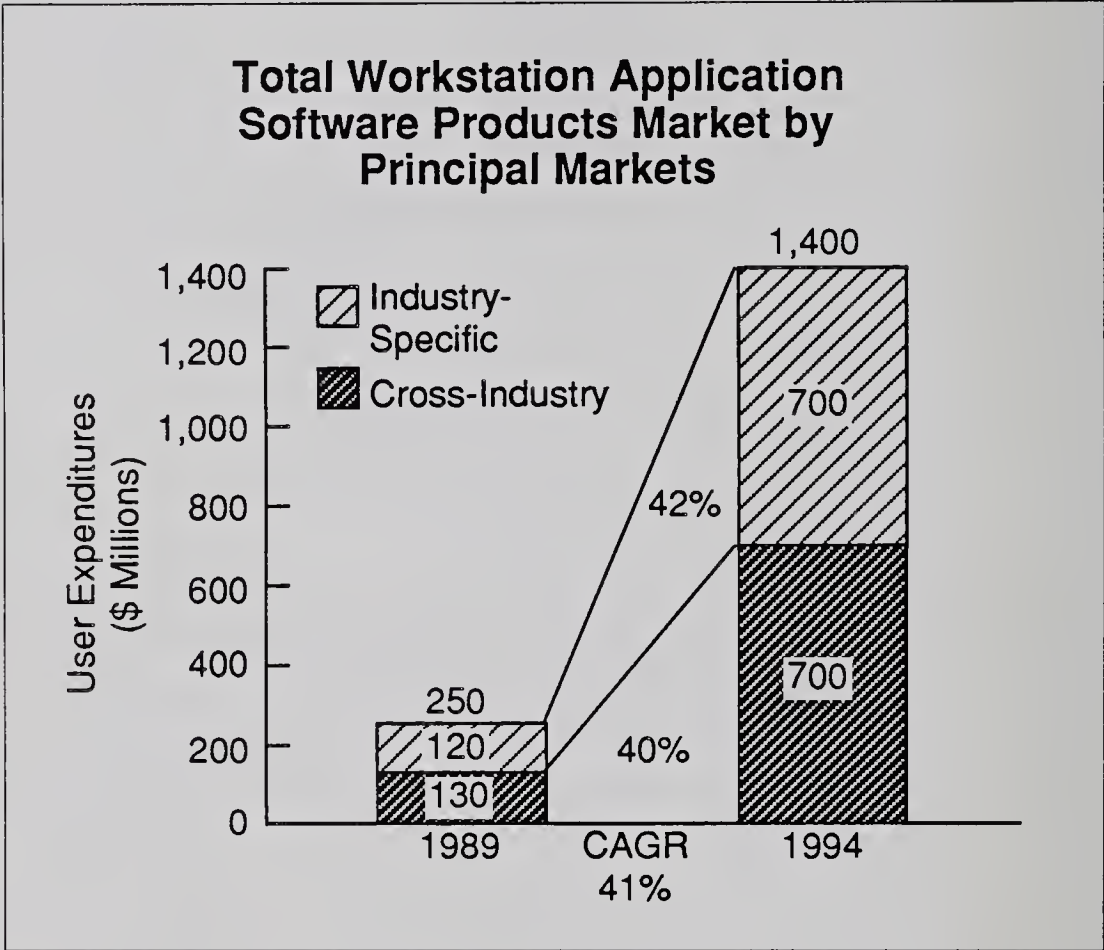
Cross-industry application software provides solutions for common functions in a number of different industries such as accounting, education and training, and office systems.

Exhibit V-I shows the size of these two market categories and INPUT's estimated growth rate between 1989 and 1994.

Industry-specific application expenditures are expected to increase at a 42% CAGR over the next five years, from \$120 million in 1989 to \$700 million in 1994. Cross-industry application software product expenditures are expected to increase at a 40% CAGR over the same period, from \$130 million in 1989 to \$700 million in 1994. The higher growth rate projected for industry-specific solutions reflects the relative maturity of the cross-industry application markets as a result of the original application development by the leading software developers in this area.

However, within the cross-industry group, various subsegments are projected to outperform growth in the industry-specific segments. These subsegments include education and training, engineering and scientific, and office systems.

EXHIBIT V-1

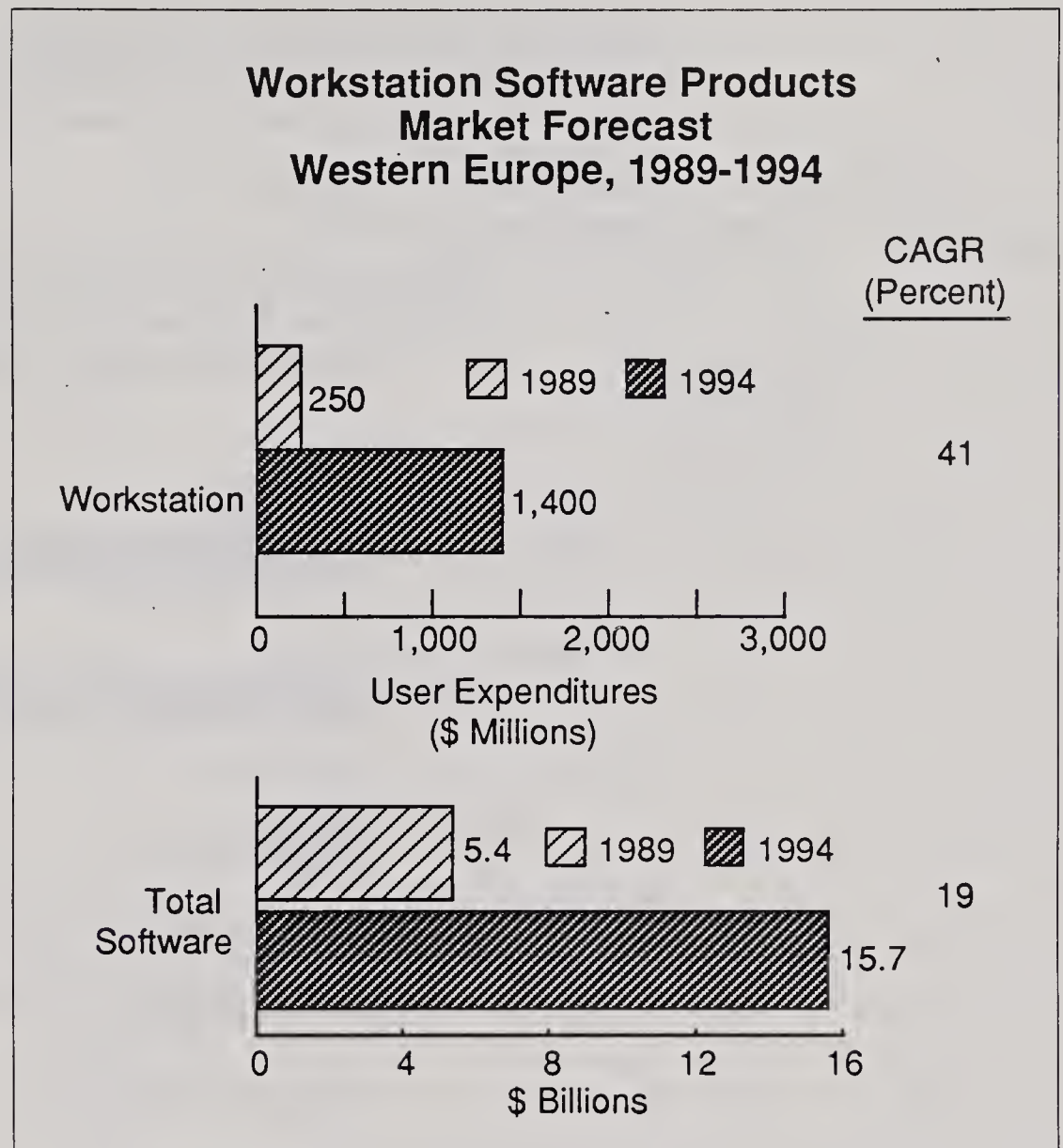


As shown in Exhibit V-2, the total applications software market for all hardware platforms is expected to increase from an estimated \$5.38 billion in 1989 to \$ 15.1 billion in 1994, a CAGR of 23%. Significantly, however, the market for workstation applications is projected to grow at a CAGR of 41%.

In a distributed processing environment, much application processing will be shifted to the workstation platform, particularly with the incorporation of the Intel 80386 and 80486, the Motorola 68030 and the new RISC chip technologies into the newer generations of workstations, which will provide mini/mainframe processing power for many applications in a desktop environment.

Application software products for vertical markets have been identified as a major market, particularly by the systems vendors who are pursuing growth through total solutions products and services marketing.

EXHIBIT V-2



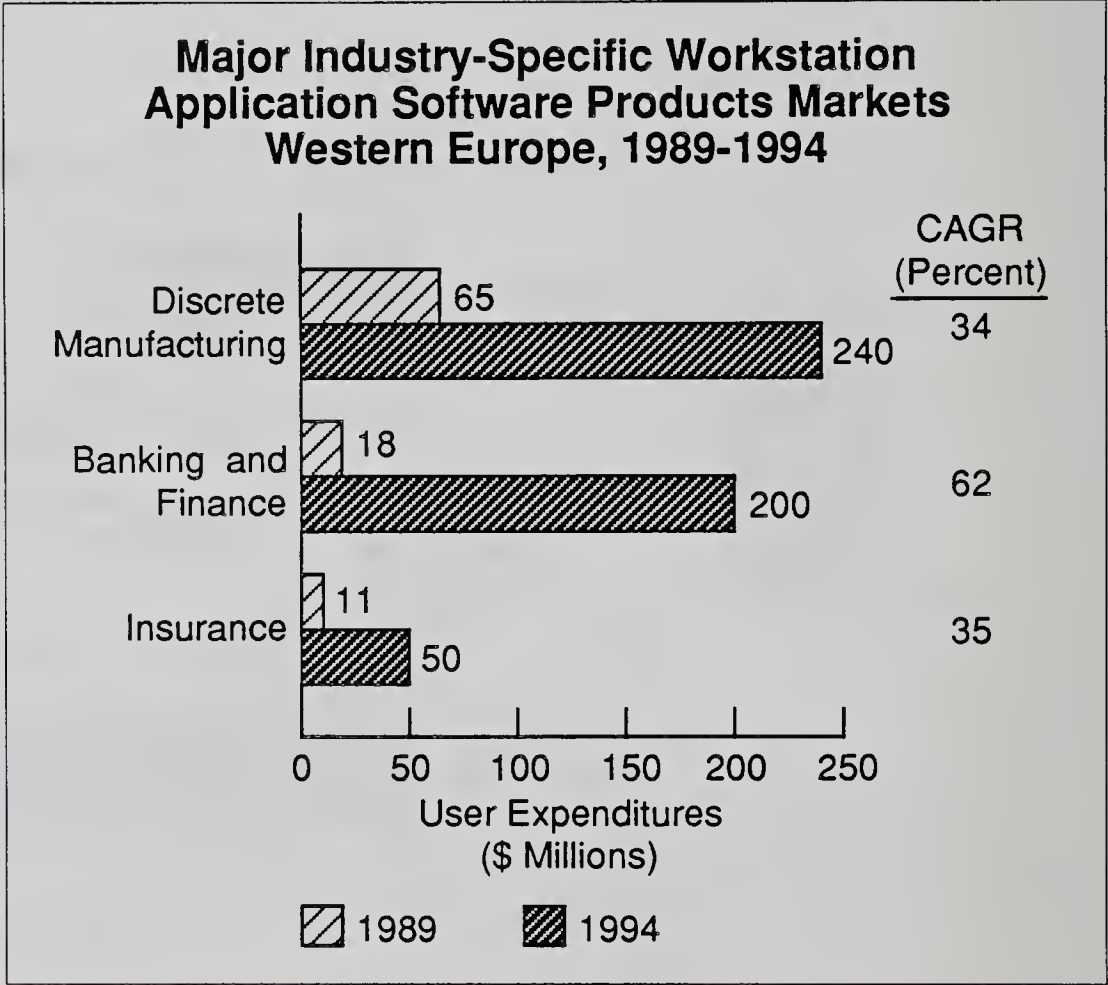
1. Industry-Specific Applications

In 1989, industry-specific markets accounted for over 4% of the total application software market. This market share is expected to increase to over 9% by 1994.

Industry-specific market sectors recording fastest growth during the forecast period will be telecommunications, retail and distribution. The high growth projected for the telecommunications and retail distribution markets reflects the strong potential in providing software products to telecommunications companies (to facilitate their entry into new information services markets) and the need among retailers to continue to reduce their operating costs through the use of new software applications. Slow growth will occur in markets experiencing budgetary constraints.

As shown in Exhibit V-3, the largest segments in the workstation industry-specific application markets were banking and finance, discrete manufacturing and insurance. In 1994, this ranking is anticipated to remain the same, with banking and finance experiencing a massive CAGR of 62%.

EXHIBIT V-3



Discrete manufacturing industry-specific application software products include: CAD/CAM/CAE software; material resource and capacity financial software and human resource products; and computer-integrated (CIM) solutions, including plantwide distributed controls. MRPII computer applications in the discrete manufacturing environment are widespread. The process manufacturing environment may also provide opportunities in this area.

The financial workstation market is already highly competitive. Key vendors are: C-ATS Software with Swapware, Riskmanager and CatWare; Integrated Analytics with Market Mind, a real-time warning expert system for dealer risk management; Thorn EMI's Software Sciences, and its NYC subsidiary FTS Inc. with its DSAS Decision Support Analysis System; and Sybase with its Interaccount portfolio management system. Significantly, Reuters is a reseller of Sun equipment.

A complete breakdown of the workstation application software products market by industry sector is provided in Exhibit V-4.

EXHIBIT V-4

**Industry-Specific Workstation Application
Software Products Market
Western Europe, 1989-1994**

Industry Sector	Market Forecast (\$ Millions)		
	1989	1989-1994 CAGR (Percent)	1994
Discrete Manufacturing	58	34	250
Process Manufacturing	3	46	20
Transportation	3	43	18
Utilities	4	44	25
Distribution	3	43	18
Banking & Finance	18	62	200
Insurance	11	35	50
Medical	7	48	50
Education	3	38	15
Services	4	43	24
Government	3	38	15
Other Industry-Specific	3	38	15
Total	120	42	700

2. Cross-Industry Applications

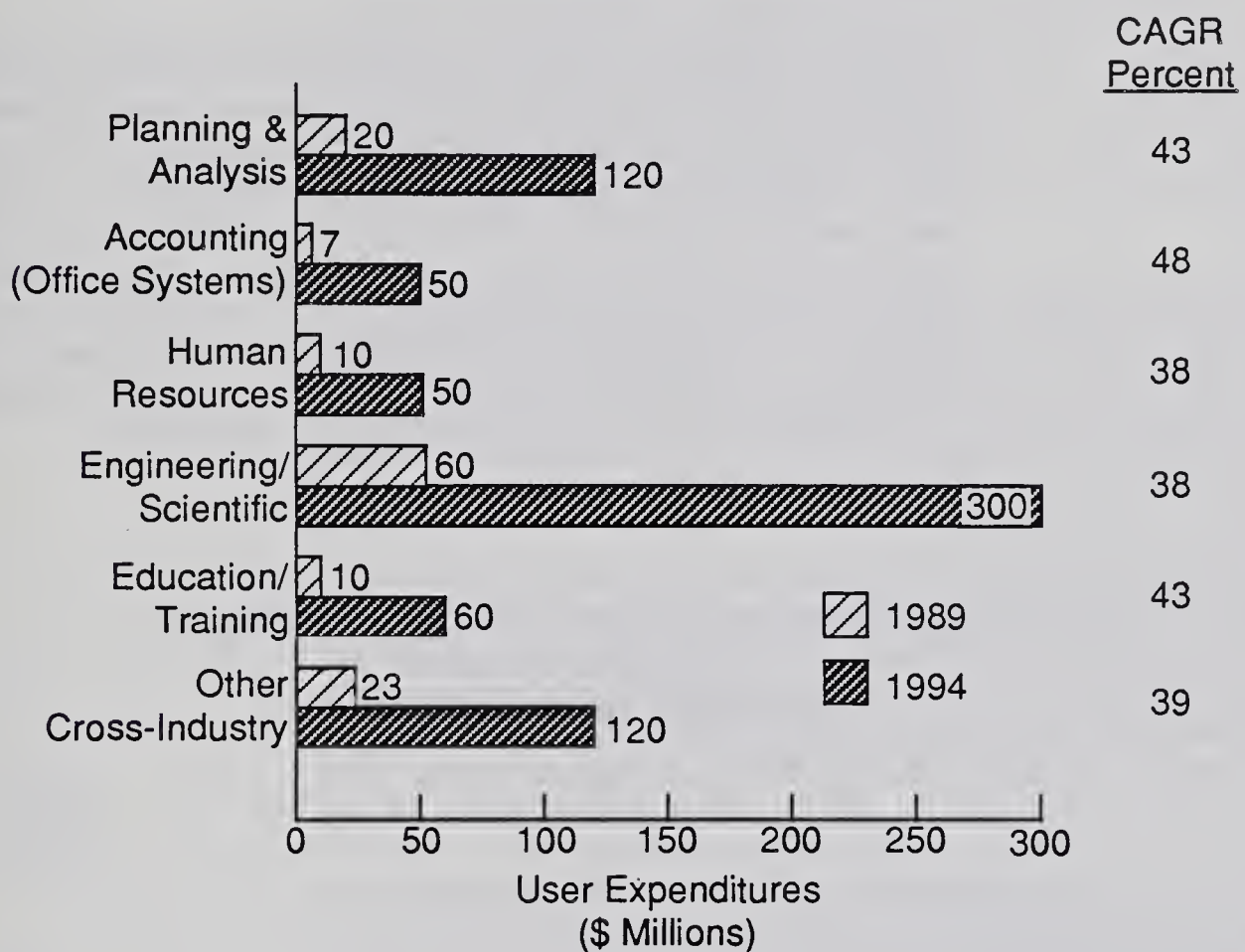
Cross-industry application software sales reached \$130 million in 1989 and are expected to reach \$700 million in 1994. The CAGR of 40% reflects the slightly faster growth expectations anticipated in the industry-specific applications area relative to the growth of cross-industry applications. This reflects the increasing requirement for mission-critical applications for particular business environments.

As shown in Exhibit V-5, the total market for cross-industry workstation applications is projected to grow from \$130 million in 1989 to \$700 million in 1994 at a CAGR of 40%. Three cross-industry segments with the highest growth over the next five years are expected to be education and training (43%), engineering and scientific (38%)—which includes approximately 70% of CAD and CAE applications, finite element analysis and certain architectural and civil engineering programs—and office systems (48%).

The office systems market is expected to benefit from emerging technologies targeted for the office system environment—including text management, voice response/voice messaging, image/compound document processing, and executive information systems (EISs). EISs are expected to show rapid growth, with the incorporation of more intuitive-type user interfaces in the PS/2 environment, and with the implementation of distributed database management solutions capable of providing transparent access to corporatewide information resources.

EXHIBIT V-5

Cross-Industry Workstation Application Software Products Market Western Europe, 1989-1994



B

System Software

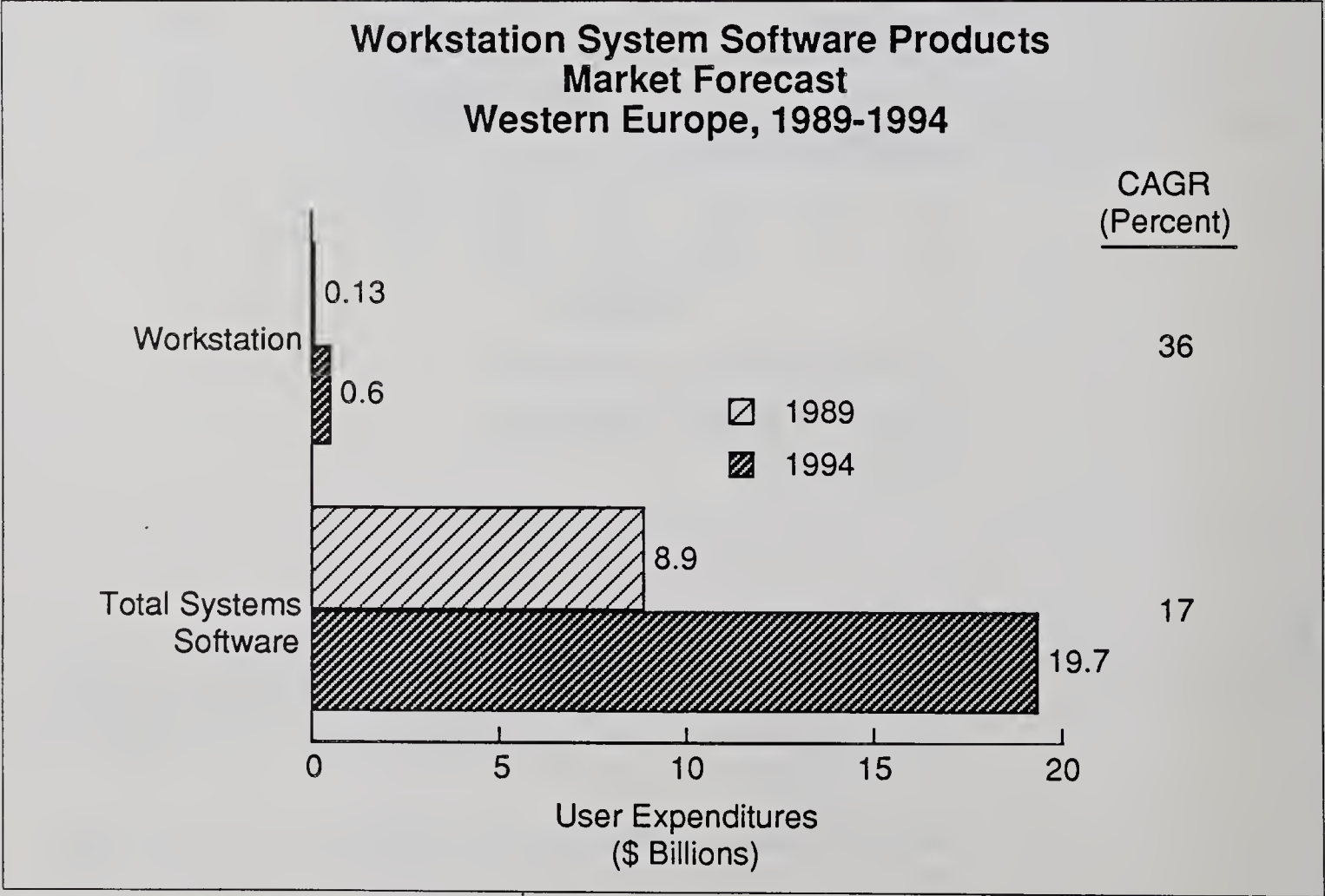
System software provides the general operating and application development environment for various hardware platforms. INPUT divides the system software market into three major submodes: systems control, data centre management and application development tools and utilities.

Exhibit V-6 shows that the workstation portion of the system software market in 1989 was just over 1% and is projected to increase to 3% in

1994. This rise reflects the relative cost/performance benefits of networked workstation solutions for a number of business solutions, and the expectations for strong growth in the distributed computer processing model. The rise also involves the continuation of a downward migration of systems software—traditionally run on mainframe platforms—to the 32-bit-microprocessor-based workstation platforms (such as application development tools) that retain most of the system software functionality.

In the future era of cooperative processing solutions, much of the application processing will be done at the workstation platform, with the mini-computer filling the role of a network server/intelligent communications processor and the mainframe being used for computer-intensive scientific and transaction processing (database access) applications. In addition, dedicated workstations and systems software solutions for specialised applications processing will become more popular. The highest growth system software markets are expected to be in applications development. This market is benefitting from new generations of tools that can be more easily integrated into traditional application development methods and have the potential of significantly improving productivity.

EXHIBIT V-6



C

Driving Forces in the Workstation Application Software Market

In the market for application software products for workstations, factors that will foster an above-average growth rate are shown in Exhibit V-7 and can be detailed as follows:

- The major trend for the 1990s will be the move to distributed processing or downsizing of mainframe applications. Many users finding the mainframe applications complex and cumbersome, requiring many hardware and support resources. With the advent of more-powerful personal computers and distributed processing networks, these applications can be efficiently run at a much lower cost. In the 1990s, there will be a number of large companies dismantling their IS departments in favour of distributed processing.
- The migration from PCs and workstations as standalone devices to a cooperative processing network is a driving force for the workstation software market. Software must be redesigned or modified to become part of the network schema. PCs and workstations are moving from isolated standalone computing devices to networked members of an information-sharing or cooperative network.
- There is also a requirement for more-advanced integrated applications to run the user's business, in view of the newer technology in equipment and the graphical interface and embedded intelligence areas. Since more of the mainframe work is downsizing to the desk-size workstation level, and since LANs are linking multiple areas, users need integrated applications that will serve multiple departments and provide a total environment.
- CPU population growth—the large installed base of personal computers will need additional applications. In the corporate sector, many personal computers are being utilised for only one or two applications. The number of applications must be increased to improve the efficiency of personal computers.
- Standards—as standards such as UNIX, SAA and SQL are adopted, it will become easier to write software for a larger number of platforms. In addition, new standards in the area of application development tools—providing common user and programming interfaces—will increase software development productivity as well as provide for software portability.
- Workstation power—The increasing power of the new workstation platforms is creating new opportunities to write programs incorporating the new capabilities of these machines. In particular, the networking capabilities inherent in these computers is creating market opportunities for multitasking and multiuser applications.

- Industry-specific applications—much of the application software has been relatively superficial in terms of problem solving. The demand is increasingly for software to provide in-depth solutions.
- Executive information systems—the need exists for free-form access to corporate information sources, including databases, particularly for corporate decision-makers.
- Application complexity—There is a need to provide second and third generations of applications software for business, including more integration and embedded intelligence.

EXHIBIT V-7

**Workstation Software Products Market
Driving Forces**

- Distributed processing
- Cooperative processing
- CPU population growth
- Standards
- Workstation power
- Industry-specific applications
- Executive information systems
- Application complexity

These factors are more fully discussed in the following chapter.

D**Inhibiting Forces in
the Workstation
Application Software
Market**

Inhibiting forces that will impact market approach growth are shown as Exhibit V-8 and can be detailed as follows:

- Product life cycles—shortening product life cycles, related in part to decreasing life cycles in hardware platforms, are creating demand particularly for application software upgrades. However, a related issue is whether independent application software developers are creating sufficient profit to support the high levels of research and development spending to compete in a crowded market.

- Crowded market niches—many application products represent mature markets where only two or three players can succeed. In addition, major R&D expenditures will be required to remain competitive.

EXHIBIT V-8

**Workstation Software Products Market
Inhibiting Forces**

- Product life cycles
- Crowded market niches
- Profitability of software companies
- R & D expenditure

E**Driving Forces in the
System Software
Products Market**

To illustrate the potential of the workstation software market, it is worth considering the driving forces in the system software products market. These are summarized in Exhibit V-9:

- New applications software growth—The increasing requirement for more-complex application software solutions is fueling the demand for new operating systems, data centre management programs (such as expert-system-based performance management tools) and new application development tools.
- Data centre management tools—As data centres become more complex, as a result of a trend to data centre consolidation, one way to reduce manpower costs is by investing in automation tools to more efficiently operate and tune system performance.
- Relational database management systems (RDMSs)—Most new computer system specifications today require relational database management systems products.
- Cooperative processing—An ultimate goal of a truly distributed processing environment is cooperative processing capabilities, which maximise the efficiencies of computer networks. Cooperative capabilities will require new generations of software products, particularly in the areas of network operating and management systems.

- CASE/4GL—There will be an increased need to improve software development productivity via fourth-generation languages. Integrated structured programming methodologies such as CASE will continue to gain in popularity.
- Standards (UNIX)—Increasing emphasis on standards and open systems should fuel the demand for new generations of systems software that conform to the emerging standards.

EXHIBIT V-9

**Driving Forces in the
System Software Products Market**

- New application software growth
- Data centre management tools
- Relational database management systems (RDBMSs)
- Cooperative processing
- CASE/4GLs
- Standards (UNIX)

In conclusion, INPUT anticipates growth in the workstation software market share for the following reasons:

- The anticipated strong growth of UNIX and OS/2 software in distributed processing environments
- Requirements for communications software protocol conversion and inter-LAN connectivity
- The workstation's inroads into the traditional minicomputer market

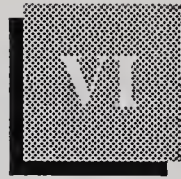
A further trend in CASE technology is workstation-based application development with front-end design/prototyping activities performed on the workstation and then uploaded to the mainframe for application code generation.

The trend to client/server and peer-to-peer processing models, where the workstation does the front-end application processing, and minicomputers and mainframes are utilised more for on-line transaction processing and network management, will help facilitate the trend to the workstation platform for application development.



Product Development Issues





Product Development Issues

A

Industry Structural Changes

The general software products environment is currently affected by a number of interrelated external and internal factors that will have a significant impact on the way the software products industry develops over the next five years. These factors are shown in Exhibit VI-1 and are as follows:

1. Internal Factors

- **Industry specialisation:** the leading independent software developers have enjoyed strong revenue growth by providing broad-based solutions targeting several industry groups. The emphasis has now shifted towards targeting vertical markets; these markets will provide significant opportunities over the next five years, particularly in telecommunications, distribution and banking and finance.
- **Product development and product maintenance:** application development backlogs at user locations are leading to interest within the software development industry in the newer application development tools—such as CASE, expert systems programming environments for embedding knowledge-based solutions into traditional data processing applications, and 4GL/DBMS/data query languages and utilities.
- **Mergers and acquisitions:** the increased activity in mergers and acquisitions has been caused by the number of similar product offerings, which in a merger can lead to a reduction in overhead redundancies and the benefits of economies of scale and cost benefits of buying niche product solutions rather than developing internally. The recent merger/acquisition between McCormack & Dodge and MSA to form Dun & Bradstreet Software Services is an indication of this trend.
- **Alliance building:** the requirement for integrated solutions involving multivendor solutions as well as the need to increase revenue from additional product offerings is resulting in a period of alliance-building

throughout Western Europe. It is important for independent software vendors to build alliances with the larger players in the hardware industry and to work with operating systems that will survive an inevitable shakeout during the transition from proprietary to standard systems offerings.

- **Distribution:** vendors are increasingly seeking multiple distribution channels such as VARs, cooperative marketing partners and new OEM relationships.

2. External Factors

- **User Needs:** As end users become more knowledgeable computer users, they need sophisticated application solutions. Users need to be able to access data and applications as well as share physical resources within a heterogeneous hardware environment. These needs require solutions with conductivity and cooperative processing. Furthermore, users want more control over shaping program development and thus increase demand for products such as object-orientated programming environments. Also, users will want to be able to access integrated information management resources (image, voice, text and graphics) through user-friendly access methods. These factors are shown as Exhibit VI-1.
- **Technology:** software developers are having to adapt their products to a number of computer systems technologies, network architectures and operating systems to capture the higher growth potential of the leading-edge hardware and software technologies. These technologies include AS/400; PS/2; parallel processors; networks (wide area and local area); optical disk storage, on-line transaction processing systems, the UNIX, PICK and OS/2 operating systems; server/client distributed processing and cooperative processing networking solutions.
- **Commercial Environment:** the increasingly competitive marketing environment in Western Europe precipitated by the European Commission's moves to deregulate telecommunications and to open the markets is resulting in a more aggressive software effort from the large computer systems vendors, as evidenced by IBM's Application Development Division.

EXHIBIT VI-1

Industry Structural Changes	
Internal Factors	External Factors
<ul style="list-style-type: none"> • Industry specialisation • Product development and maintenance • Mergers and acquisitions • Alliance building • Distribution 	<ul style="list-style-type: none"> • User needs • Technology • Standards • Commercial environment

3. The 1990s

The smaller independent software vendors will need to create cooperative marketing alliances with larger vendors to compete effectively on a marketing level. The competitive impact from control over source/object code involving de-facto software standards such as AT&T's UNIX System V is also creating cooperative power blocs such as the Open Systems Foundation and UNIX International.

Leading vendors in various software markets have been expanding product offerings into related software service areas such as consulting, education and training, software development, systems integration and software integration.

As many software product areas evolve into commodity offerings with comparable product offerings by several companies, more emphasis on value-added servicing capability and customisation is often required to maintain growth, increase profitability and maintain account control.

In conclusion, the software industry has been undergoing a basic structural change over the past few years that has involved a major expansion into related support services. In order to remain competitive as well as to obtain additional sources of revenue, software suppliers have been steadily expanding their program offerings into the professional services and, more recently, the systems integration markets.

With the trend to distributed processing solutions involving multivendor architectures as well as a number of integrated software/hardware technologies (such as image, integrated voice/data and communications), systems integration capabilities are becoming more important for capturing the larger contracts for software solutions. Further emphasising this trend are user demands for complex solutions.

In order to offer the broad range of software and services products that will be required to compete in many market segments in the 1990s, independent software developers and equipment vendors have been developing strategic alliances and more-secure positions through mergers and cooperative marketing agreements with smaller independent software developers that can provide leading-edge niche solutions.

Application development environments—such as SAA and Presentation Manager from IBM, DECWindows, NewWave from Hewlett-Packard and Open Look from Sun Microsystems and AT&T—provide another key competitive element that independent software developers must consider for future product offerings. It is important for independent software developers to consider which hardware platforms and operating systems will survive the inevitable shakeout in the computer systems industry in the 1990s as hardware becomes more of a commodity product and the operating systems market tends toward standard open-systems products.

B

Technical Issues

1. RISC Microprocessor Technology

There will be an increasing need for application software for anticipated accelerated introduction of workstations based on RISC (reduced instruction set computing) microprocessor architectures such as the Sun SPARC and Intel 80960. Leading vendors are listed in Exhibit VI-2. A number of new RISC processors are being optimised for UNIX. The PICK operating system and the RISC architecture are very compatible—thus the RISC environment will also provide an opportunity for application software developers working with PICK.

EXHIBIT VI-2

Leading Vendors of RISC-Based Processors

Company	Product	Computer System Manufacturers	Computer System Manufacturer Licenses
MIPS	RISC Compilers	<ul style="list-style-type: none"> • Ardent • MIPS • Prime • Racal Redac • RC Computers • Rolm Mil-Spec • NEC • Seiko • Silicon Graphics • Sony • Sumitomo • Tandem • TIS 	
Sun	SPARC	<ul style="list-style-type: none"> • ARIX • AT&T • ICL • Sun • Unisys • Xerox • Daratech Enterprises • Tatung Co. • Toshiba 	
HP/Apollo	PRISM 9000		<ul style="list-style-type: none"> • Apollo • HP • Hitachi
IBM	RT		<ul style="list-style-type: none"> • IBM
Intergraph	Clipper		<ul style="list-style-type: none"> • Intergraph • Philips

INPUT estimates that CISC-based technical workstations accounted for approximately 85% of units sold last year and does not anticipate that RISC will overtake until 1992. However, the high cost of RISC machines means that in revenue terms RISC processors had 24% of a \$4 billion market in 1988. By 1992, as unit costs come down, workstation shipments will approach one million per year. However, the development of the Intel RISC microprocessor (the i860, which Olivetti, Ardent and Altos have said they will be incorporating) will impact the market.

The basic advantage of RISC is that it enables computer/workstation manufacturers to adopt the 64-bit architecture and performance normally associated only with supercomputers, dedicated graphics supercomputers or minisupercomputers.

The significance of the i860 is that it will dent the expectations of a host of companies that have produced RISC microprocessors in the hope of breaking the Intel/Motorola stranglehold on the microprocessor market that has existed for almost 20 years.

Companies with RISC products are as follows:

- Motorola 88000
- Acorn Archimedes Advanced Micro Devices 29000
- Sun SPARC (made by Fujitsu, LSI Logic, Cypress Semiconductor, Texas Instruments and Bipolar Integrated Technology)
- MIPS R3000 (made by Integrated Device Technology, NEC, Siemens, Performance Semiconductor and LSI Logic)
- Intergraph's Clipper
- Inmos' Transputer
- Siemens' Hyperstone

Because RISC has given rise to all these hopeful rivals to the Intel/Motorola dominance in microprocessors, it has been termed the "last hope of the have-nots" by Intel.

2. Standards

As mentioned in previous sections, standards are still evolving in the workstation software market. Users want standards to facilitate application interconnectivity. Software vendors are either promoting their own software as a standard, covering all of the standards with their software, or waiting to see what will emerge as the standard before investing resources in new software development.

Adherence to standards will be a requirement for competitive viability in the longer term. Standards under development include the following:

- *Screen:* Windows, Presentation Manager, NeWS NewWave, NextStep, GEM, Display Postscript
- *Graphics:* DMS, CGM, CGI, TIFF, PICK
- *Communications:* OSI, SNA, Ethernet, Token Ring, TCP/IP
- *DBMS:* SQL, DB2
- *Printers:* Postscript
- *Operating Systems:* MS-DOS, OS/2, UNIX, PICK

UNIX is likely to represent the strongest growth rate among mainstream operating systems over the forecast period. The PICK operating system is also continuing to gain acceptance in the minicomputer environment, its traditional base, and more recently in the RISC workstation environment.

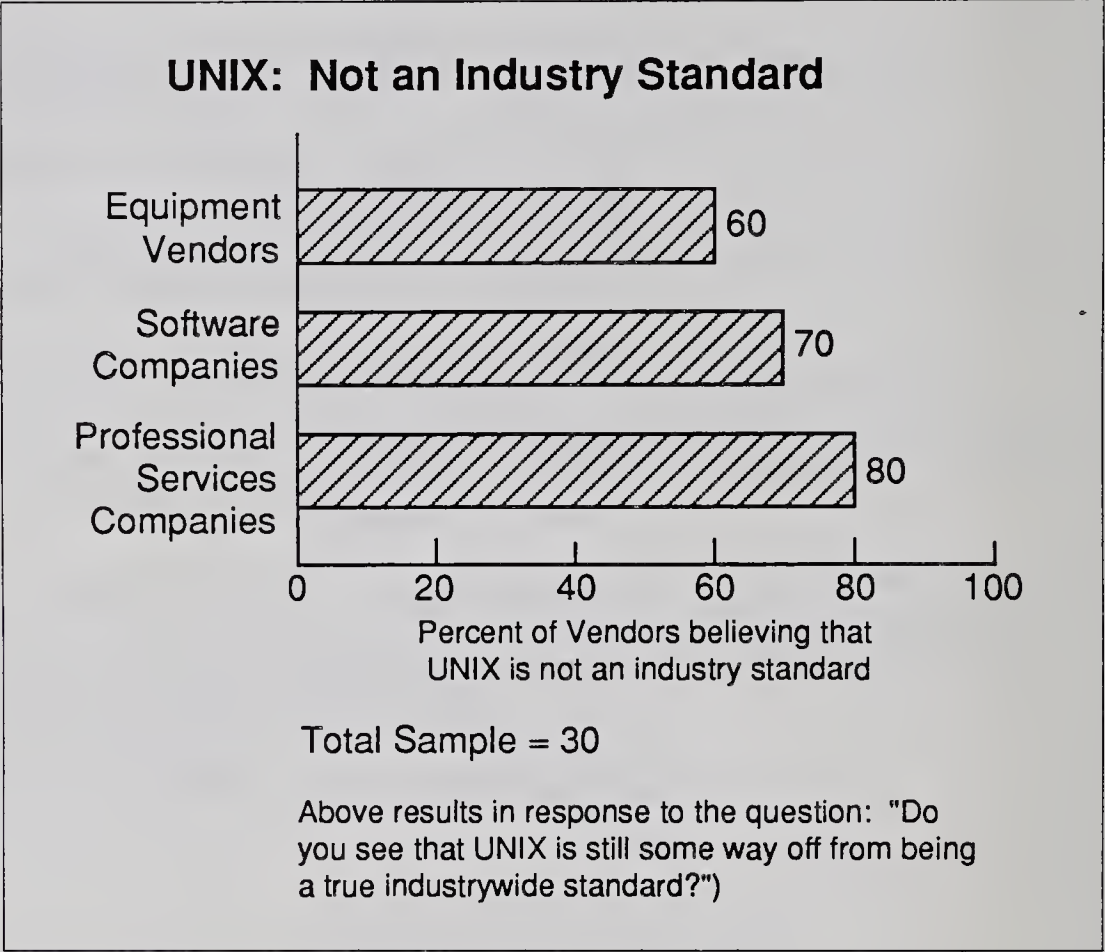
a. DOS versus UNIX

In order for workstations to make the important crossover into the corporate sector, DOS software companies need to start developing for UNIX: PC users need to be able to upgrade without having to learn new software and convert data files.

Currently (December 1989), only three major DOS software companies have developed their products for UNIX: Sentinel Software with WordPerfect, Autodesk with AutoCAD and Microsoft with Word. Of these, only AutoCAD and WordPerfect have been developed to exploit the full power of UNIX workstations.

Two other major U.S.-owned independent software companies are looking to launch products in 1990—Ashton-Tate with dBase and Lotus with 1-2-3. In both cases what they hope to achieve is interconnectivity of DOS, UNIX and OS/2. Lotus is producing a full graphical version of 1-2-3 for workstations, but Ashton-Tate has no intention of producing anything other than a standard UNIX terminal version. Vendor attitudes towards UNIX as an industrywide standard are given in Exhibit VI-3.

EXHIBIT VI-3



Lotus has established a workstation division, claiming that "UNIX is the only operating system in the history of operating systems that has a chance of being a pervasive standard. There are strong forces behind OS/2 but certainly in numbers they are nowhere near the forces behind UNIX. The number of organisations behind UNIX is unique in the history of the computer industry." A summary of vendor attitudes towards UNIX in general is given in Exhibit VI-4. As well as developing Lotus 1-2-3 for Sun and HP workstations, Lotus is also developing a financial modelling package for NeXT workstations.

Two key differences separate DOS software companies from UNIX software companies. Firstly, DOS software companies with a potential market of 15 million units can highly optimise their software to the Intel 8088 and the IBM PC's architecture. Screen writes, custom disk formats and low-level keyboard-handling routines are all commonplace in the PC market because the machines are virtually identical.

Secondly, UNIX software companies confronted by a multiplicity of different platforms—mainframes, minis and workstations—attempt to make their C code as portable as possible. For the most part this means that applications are character-based (lacking bit-mapped graphics) and are therefore too slow.

EXHIBIT VI-4

UNIX and WorkstationsVendor Attitudes

Negative

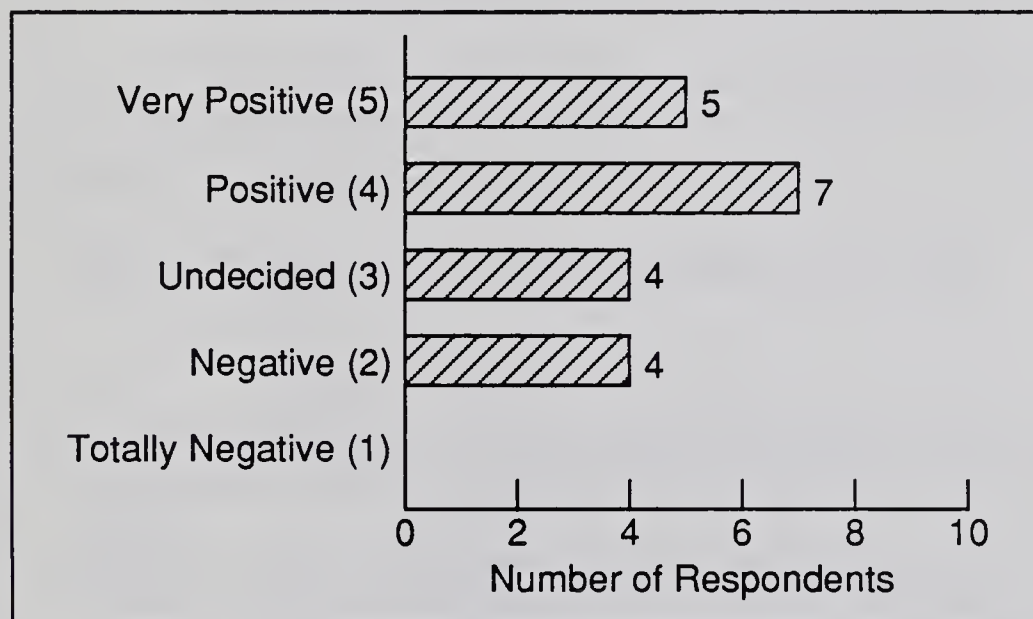
Undecided

Positive

- OSF and UNIX International need to get together and this will take some time
- IBM needs to get more involved

- There is a lack of applications for UNIX

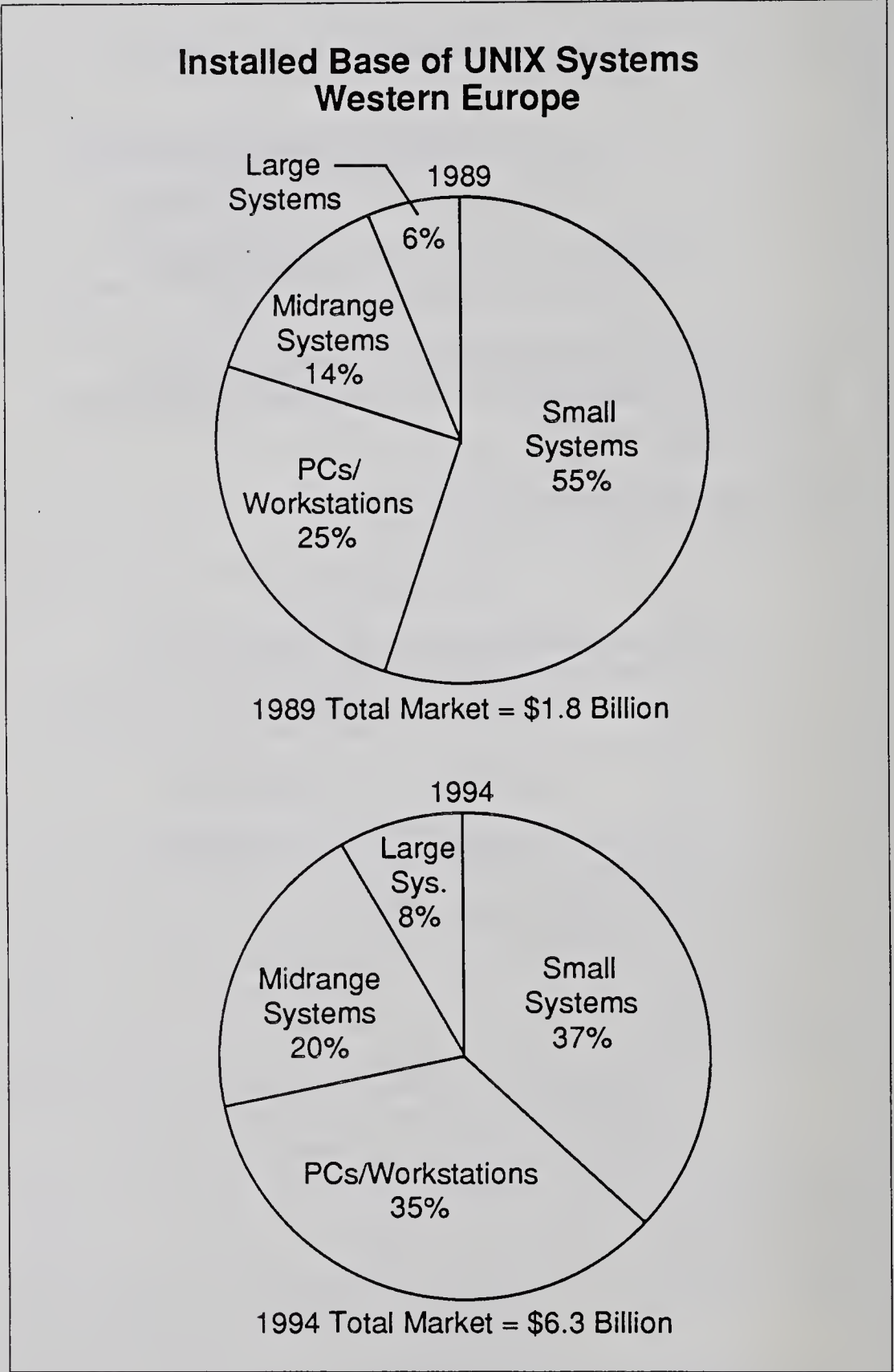
- UNIX will help us enter new markets
- Long-term benefits are enormous



(Above results in response to the question: "Could you indicate on a scale of 1 to 5 whether you see that UNIX will create a standard operating system from which vendors can sell application packages?")

INPUT's estimate of the installed base of UNIX systems in Western Europe for 1989 and the forecast for 1994 is given in Exhibit VI-5. The PC/workstation sector is \$450 million in 1989 and will reach \$2.2 million in 1994—a CAGR of 37%, slightly lower than the CAGR of overall workstation software, which will show a CAGR of 39%.

EXHIBIT VI-5



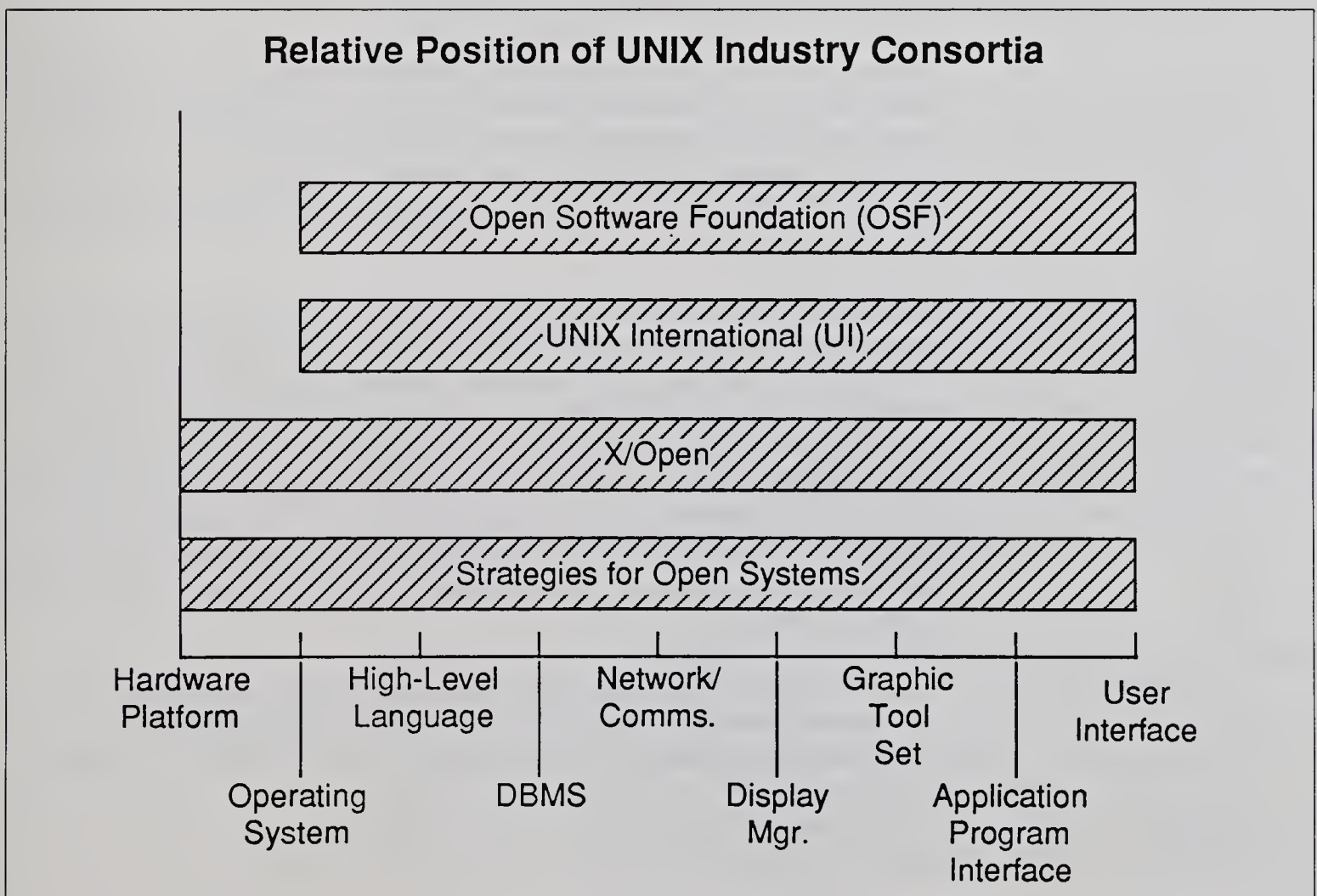
These are certainly incentives to port to UNIX, one of the largest being the opportunity it represents for entry into large corporate computing environments. The U.S. and U.K. governments are huge UNIX users—for example, over 50% of all governmental requests ask for compliance

with UNIX standards. Additionally, the DOS software houses are increasingly aware of the need to grow with their corporate customers who are installing UNIX workstations at a phenomenal rate and networking them with PCs.

Fortunately for UNIX, the DOS software companies are confronting portability issues as they make plans and commitments to OS/2 and the Presentation Manager graphical interface. Unfortunately for UNIX, the applications that the workstation makers want to see on their systems are likely to appear on OS/2 systems before they move onto UNIX. This is because DOS software companies made a commitment to OS/2 long before UNIX looked like it might become a serious challenge as an operating system.

The recent banding together of UNIX International (UI) and the Open Systems Foundation (OSF) under the banner of the X/Open Company Ltd (for a schematic representing the relative position of UNIX industry consortia, see Exhibit VI-6) indicates that the UNIX community wants to develop a standard user interface and ultimately binary compatibility. If this becomes fact, the DOS software companies could see UNIX shrink-wrapped software and a single-system approach to support.

EXHIBIT VI-6



At the moment, DOS software companies find themselves with several questions:

- Should they port to Open Look?
- Should they port to Motif?
- Should they just go ahead with standard character-based applications?
- If so, should the application follow the multiuser system model or the workstation distributed-processing model?

Even a mass-market DOS software company like Borland, which specialises in low-priced DOS applications such as Sprint and Paradox, would likely approach the UNIX market differently if UNIX had binary compatibility.

At Microsoft, home of OS/2, there is robust support for UNIX (Microsoft has developed a version of Presentation Manager for UNIX in case OS/2 flops). After Microsoft Word, the next application to be available under UNIX will be the spreadsheet Excel. Unlike Word, which can operate quite happily on a character screen, Excel needs full graphics support and a windowing environment.

There is an established route for DOS software companies to port first to SCO (Santa Cruz Operation) XENIX and from there onto Sun workstations. Several SCO applications have been successfully ported to Sun systems, including FoxBase, a software clone of dBase IV. A recent agreement between SCO and Sun should ensure that even more applications follow this route.

There is one final way in which porting to a workstation can be made much easier. Hunter Systems makes a product called XDOS (sold in the U.K. by First Software), which allows a software house to do a binary recompilation of its DOS software for the 68020 and 68030. To date, Hunter Systems has successfully ported several major DOS applications (1-2-3, Word, dBase III, and Wordstar). These applications are then run in a binary environment that reconstructs the PC. The results on a 25-MHz 68030 equate to a 12-MHz 80286 PC. So far only Ashton-Tate has confirmed the results, and hopes to offer an XDOS version of its popular dBase IV shortly.

Whatever the porting method, be it by a technological innovation or a corporate agreement such as that between SCO and Microsoft, it is obvious that most major DOS applications will be available for UNIX in the early 1990s.

A problem with UNIX is that it has no perceived benefit for many users except MS-DOS. User friendliness is not a primary issue that sells machines. It helps sales, but it is not an end in its own right. UNIX' real selling points are the fact that it is ideal for multiuser systems and is probably the only operating system with a decent range of CAD/CAM software packages running under it. In the workstation desktop market, these requirements do not exist. The criterion is networking, not multi-user capability, and the application is commercial, not technical.

Even in areas where markets are growing—database-orientated departmental systems, for example—UNIX may have the lead in applications software, but MS-DOS is gaining ground with major database products. Indeed, the best-selling application for UNIX workstations is MS-DOS emulation with XDOS from Hunter Systems, a total software product for DOS applications to run on UNIX machines.

Hunter Systems faces competition from Insignia Solutions and Phoenix Technologies, both of which offer DOS-to-UNIX solutions. Hunter emphasises that the difference between its solution and the other companies' is that Hunter bases its approach on compiler technology, whereas Insignia and Phoenix use an interpreter strategy. Hunter says that the strategy of simulation at run-time places several layers of processing between the PC application and the machine, considerably slowing processing time.

Hunter Systems will be selling its products first to vendors of UNIX boxes, then to software vendors (who may use the product in software conversions), and finally to end users, depending on OEM agreements.

b. UNIX—A Summary

In one respect—the UNIX standard—the European market is ahead of the U.S. market. The transition from proprietary to open systems is happening much faster in Europe than it is in the U.S. In fact, it was in response to the impending dominance of a few proprietary systems that European hardware manufacturers established X/Open. Because of Europe's lead, a large number of U.S. UNIX software companies are looking to Europe to keep ahead of developments in UNIX. Guidance is necessary not so much in terms of hardware platform, but in terms of the software standards adopted.

Nearly all the major computer systems vendors, as well as several of the leading independent software developers, have endorsed UNIX as a second operating system in addition to their own proprietary systems. In addition, several of the leading independent software developers in the microcomputer universe—such as Lotus, Ashton-Tate, Novell, and Oracle—have announced UNIX-based software packages. These packages are likely to provide the impetus for UNIX's success within the

commercial environment. Vendor opportunities in UNIX are summarised in Exhibit VI-7.

EXHIBIT VI-7

Vendor Opportunities in UNIX

- Office systems (file servers)
 - EIS (Executive Information Systems)
 - OA (Office Automation)
 - Text processing
- Business applications
 - Accounting
 - Human resources
 - Education and training
- Personal productivity software
 - Spreadsheet
 - RDBMS
 - Integrated software
- Differentiators

UNIX is anticipated to be the fastest growing operating system over the next few years. The fact that UNIX is an open system, and in the process of becoming more standardised in a computing environment that is demanding standard implementation, gives it a significant advantage. UNIX offers a strong competitive alternative in a distributed processing environment with its software portability advantages. The advantages of using UNIX are summarised in Exhibit VI-8.

EXHIBIT VI-8

Advantages of Using UNIX

- Flexibility in commercial, technical applications
- Portability
- Standard environment for application developers
- Scalable (PC-to-mainframe)
- Multiuser, multitasking
- Communication capabilities

Furthermore, UNIX is finding a niche on 80386 platforms. UNIX compiler products enable users to recompile their DOS applications, such as Lotus 1-2-3, onto UNIX. Products such as 1-2-3 could accelerate acceptance of UNIX in the workstation and microcomputer world, since these applications help preserve the value of existing DOS systems. A summary of UNIX status is provided in Exhibit VI-9.

EXHIBIT VI-9

UNIX: A Summary

- While promoting open standards, UNIX is not yet fully open.
- Though UNIX is strongest in minicomputers, the fastest growth will be in PCs/workstations.
- Any graphical user interface will foster acceptance of UNIX.
- More commercial applications are required for UNIX to be successful.

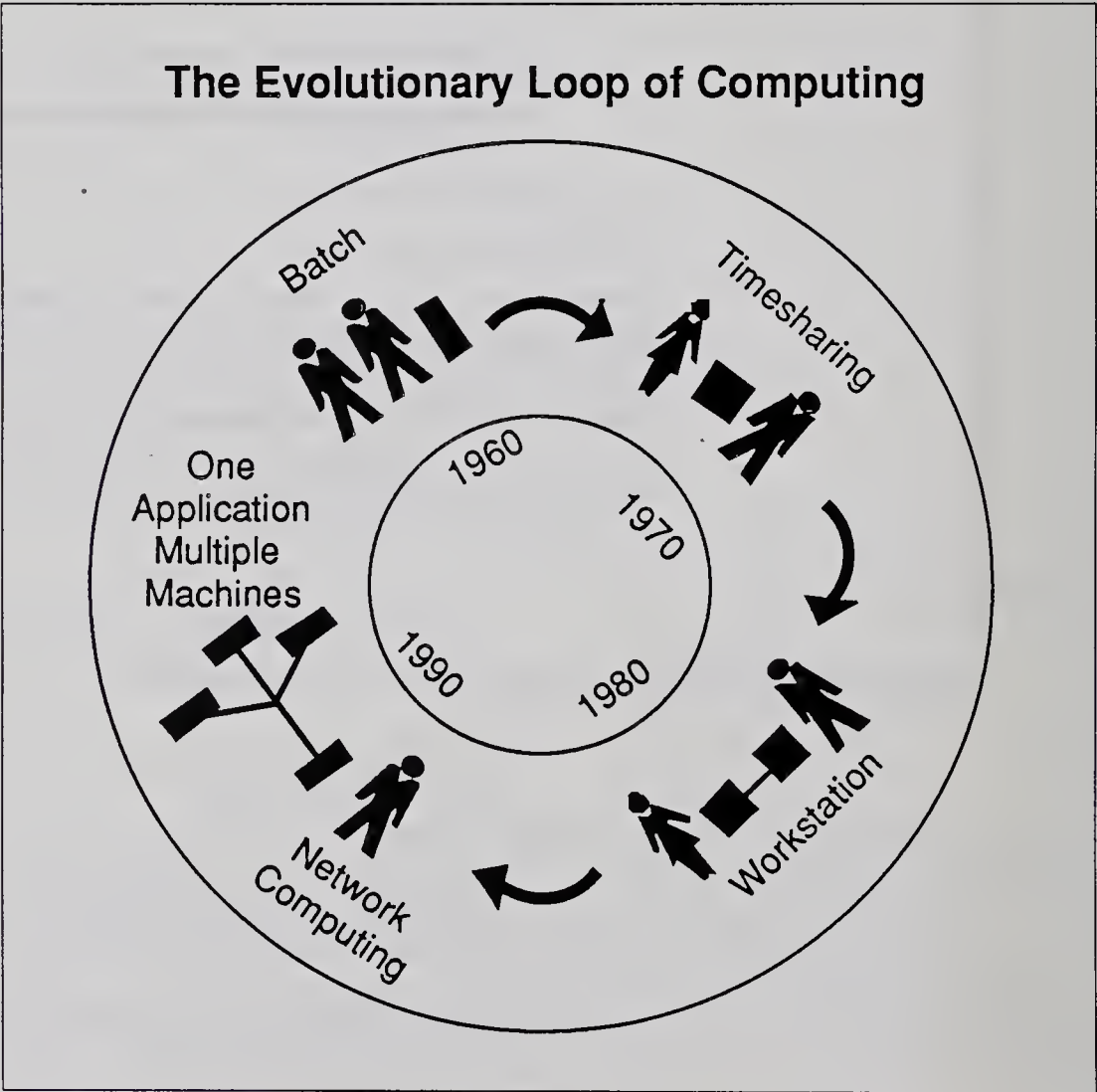
C

User Organisational
Issues

1. Networking

The increased use of workstations almost completes the evolutionary loop of computing, as seen in Exhibit VI-10. As in the early days, the user sits down and drives the resources of a single computer. However, the loop is not totally complete. With the current move towards network computing, the network is playing the key role in managing resources on the network and applying them to applications. Network computing means that a single user does not drive one, but several, computers from the workstation, with applications being processed where appropriate.

EXHIBIT VI-10



The concept of computing for the 1990s will be linking powerful micro-computers in high-speed networks, rather than many workers sharing a minicomputer or a mainframe. Workstation networks will become the dominant style of the 1990s and will impact minicomputer business. Vendors' views on the importance of cooperative processing are illustrated in Exhibit VI-11.

EXHIBIT VI-11

The Importance of Cooperative Processing

Vendor Attitudes

Negative

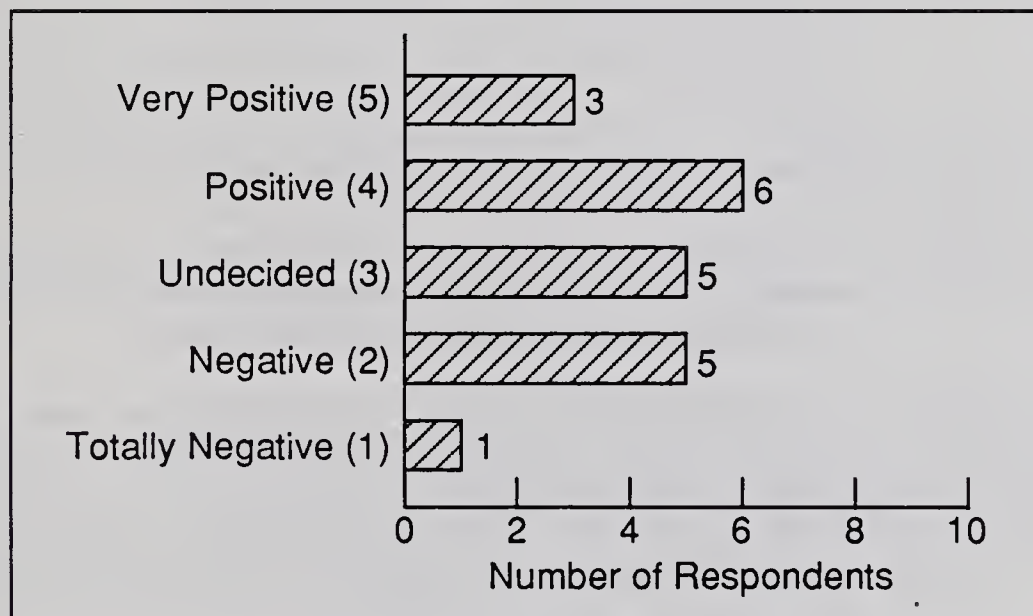
- It's still a fantasy
- Question of security is unresolved
- Lack of power

Undecided

- It's not an issue of platforms so much as solutions
- Too many issues still to be resolved

Positive

- A perfect application
- Workstations provide the ideal platform



(Above results in response to the question: "Could you indicate on a scale of 1 to 5 the importance of cooperative processing models to the development of the workstation market?")

The migration of PCs and workstations as standalone devices to networked components of a processing schema has resulted in other issues. There is a proliferation of definitions for the types of processing networks as well as the types of components in the network. The networking environment is evolving and definitions of systems are outgrowing the uses and configurations of the systems. The many types of distributed processing and cooperative processing networks include the following:

- The cooperative processing network shares processing of the information as well as access to files and databases. Cooperative processing

models include client/server, LAN-to-LAN and peer-to-peer.

- The distributed processing network is composed of workstations connected to a mainframe or a minicomputer or multiples. The workstation shares files or database access with the host computer, usually through a type of 3270 terminal emulation configuration.

The client/server model usually consists of desktop computers (clients) with front-end communications and application interfaces to workstation, minicomputer or mainframe servers. Servers provide shared database and/or application access by desktop-based client machines as well as access to other databases and applications on the networks.

LAN-to-LAN processing shares files and information within the LAN and with other LANs. Each LAN performs processing within the configuration and then shares the files and databases with the other LANs.

Cooperative processing will ultimately move towards the peer-to-peer processing model, in which the application layer runs independently on each platform. Such a processing environment exists when the application is resident on different-size platforms and each performs the portion of the processing that is most efficient for its configuration.

One of the major issues concerning applications or application development in the networked environment is multiple users updating and accessing the same information at the same time.

In the CASE development area, companies have experienced delays in updates being incorporated into databases used for product development when development products are run on a LAN. In the CASE environment, multiple users are trying to coordinate a design based on input from other people in the organisation. Control and management are the most important issues to consider when planning distributed processing with development tools such as CASE.

In conclusion, future distributed processing models will provide cooperative processing solutions that include transparent access to distributed applications as well as data, communication and printer resources across and among various computer platforms and operation systems. Included below are current products that incorporate elements of a cooperative processing model:

- Apollo Computer's Network Computing System is an application development technology for implementing a cooperative/distributed processing environment. Introduced in early 1987, it is an open network product family that provides an architecture for networkwide sharing of computer programs and other resources. To promote its open network systems strategy, the company has licensed the application development technology to IBM, amongst others.

- Sun Microsystems has also developed the Network Software Environment (NSE), a network CASE system for software developers working on large-scale projects involving heterogeneous machines. Sun intends the system to provide access to all the major operating system environments that support Sun's Network File Systems (NFS) architecture.

Sun furthered its activities in the distributed systems market with the launch of a suite of open networking products. At the heart of the announcement is Sun's entry into the important network management arena. Sunnet Manager is aimed at distributed systems on networks based on TCP/IP. All networking resources—computers, bridges, software, and services—are managed under the product.

Although Sun has invested previously in network technology, particularly in developing the industry standard Network File System (NFS), the company's announcement in October 1989 marked a fundamental shift in strategy. Known primarily for selling low-end workstations, Sun's new policy means that it is entering a market full of departmental systems specialists such as Digital and Hewlett-Packard.

Sunnet is similar in breadth to the networking solutions of companies many times larger than Sun. The new products raise the standards for vendors wishing to compete as suppliers of distributed systems. Other products announced include a software license management package for Sunnet, allowing what Sun calls concurrent usage licensing methods in which licenses float between multiple users.

Sun has also entered the market for fibre distributed data interface (FDDI), the 100-Mbits-per-second high-speed networking standard expected to be ratified in 1990. The company has developed a channel gateway that links Sun computers with IBM 370 and compatible mainframes, which allows exchange of files and messages.

2. Departmental Computing

There is a trend among computer systems vendors to integrate vertical and horizontal applications with their system software products (operating, communications and database management systems software) into departmental computing solutions. Vendors' attitudes to departmental computing are given as Exhibit VI-12.

EXHIBIT VI-12

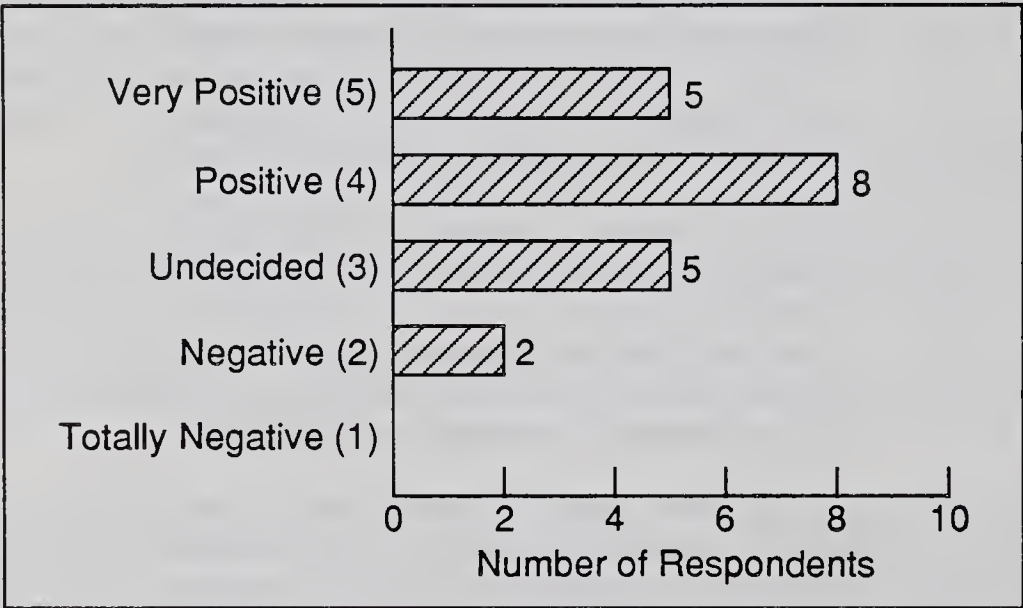
Departmental Computing: Internetwork Connectivity

Vendor Attitudes

- Negative

Undecided

Positive
- Third parties need more support.
 - Operating system still a question
 - Departmental computing is a major growth area
 - Too many imponderables
 - UNIX will drive this



(Above results in response to the question: "Could you indicate on a scale of 1 to 5 the importance of the workstation platform in the provision of internetwork connectivity?")

Much of the vertical software is coming from third-party developers. Computer systems vendors need third-party developers as they accelerate their efforts to market application software. This need leads to an acceleration in the number and varieties of cooperative marketing relationships among computer systems vendors and third-party software developers.

One of the major issues for independent software developers is to determine what operating systems and platforms will dominate the future departmental computing environment.

With the integration of horizontal and vertical applications and communications software on the same server (minicomputer, workstation, or PC) platform, multiuser and multitasking operating systems capability and hardware performance capability to act as intelligent communications nodes become important selection criteria.

At this point it would appear that minicomputers as well as workstations will have a major role to play in this market that requires inter-network connectivity.

In addition, UNIX will gain in popularity in this environment because of UNIX's multiuser functionality and capability for facilitating the development of client/processor cooperative network processing architectures.

3. Artificial Intelligence

Vendors interviewed by INPUT attributed the renewed popularity of AI technologies to several factors:

- Porting of the traditional AI programming languages such as LISP to the less costly, general-purpose workstation platforms (Vendors' attitudes to this particular task are given in Exhibit VI-13.)
- The use of C programming languages with AI extensions—such as C++, originally developed by AT&T—which expands the availability of the product as measured in hardware and programming costs and flexibility of use
- The vast improvements in CPU and memory price/performance over the past ten years, which makes the use of AI programming technologies much more cost-effective

EXHIBIT VI-13

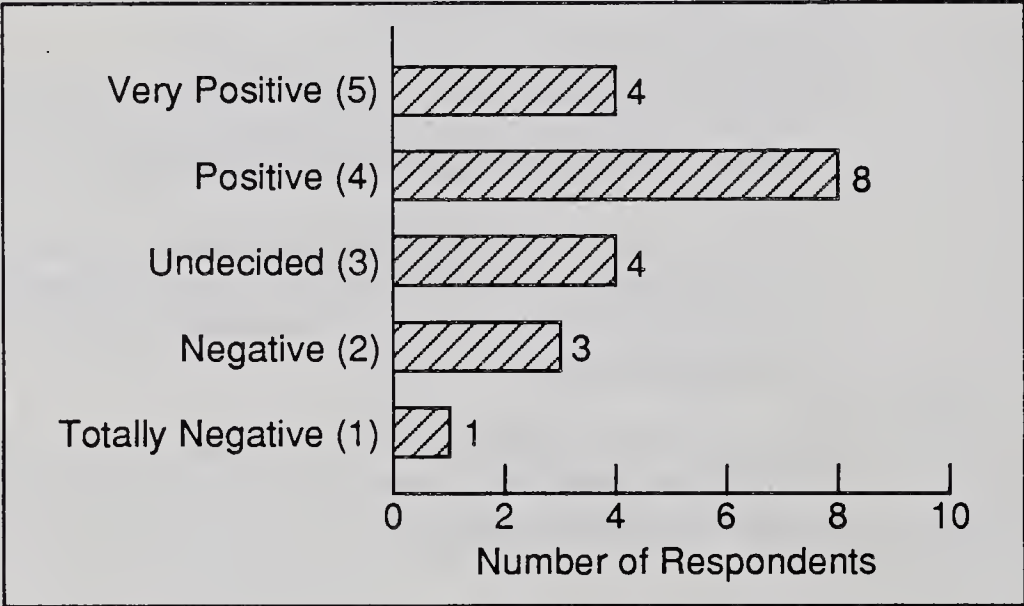
AI in the Workstation Market

Vendor Attitudes

- Negative

Undecided

Positive
- AI is still too complex
 - Helps costs
 - Don't think it's an issue
 - Portability will provide stimulus
 - Price/performance has changed the market
 - CASE development tool



(Above results in response to the question: "Could you indicate on a scale of 1 to 5 the benefits of the workstation in enabling the traditional AI programming languages such as LISP to be ported down?")

Newer expert systems shell development programs written in the C language family, which incorporate AI-based rule-making and frame/object technologies, represent a much more efficient and flexible tool for integrating knowledge-based/intelligent functionality into the traditional environment than the first generation of expert systems shell programs based on specialised AI languages and hardware platforms.

Particular benefits include the ability to incorporate human reasoning/expertise into critical and other applications that require decision-based processing. In addition, application prototyping, when used as a CASE development tool, can be significantly enhanced; developed software modules become reusable, which can also significantly improve programming efficiencies.

With Symbolics' announcement that it will be delivering its software on Sun workstations (the UX400S—a high performance, plug-in coprocessor), Symbolics' object-orientated software environment will enable users to run other UNIX applications alongside Symbolics software on a single workstation.

Macintosh users were able to benefit from Symbolics' software in 1988, and Macintosh applications have since accounted for about 25% of Symbolics' new-product sales. Opening the door to Sun users will bring Symbolics similar success as well as provide Sun with high-end AI development capabilities that extend the appeal of Sun's workstation in this sector. A vendor commented: "Users are looking to extend the delivery of our AI techniques, expert systems and object-orientated programming. To do this they need software to run on the less expensive, popular workstations."

4. Open System Architectures

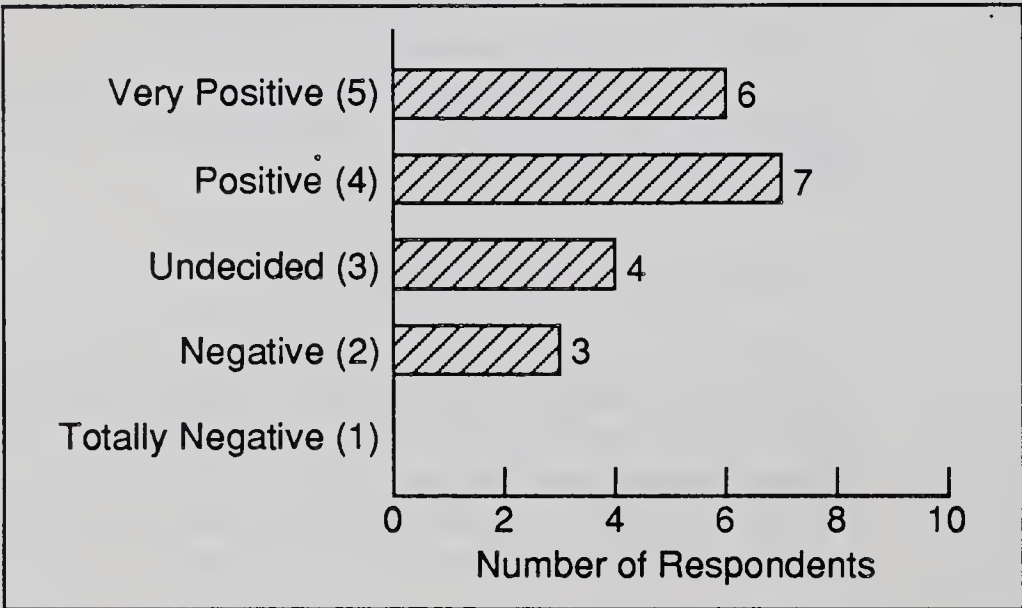
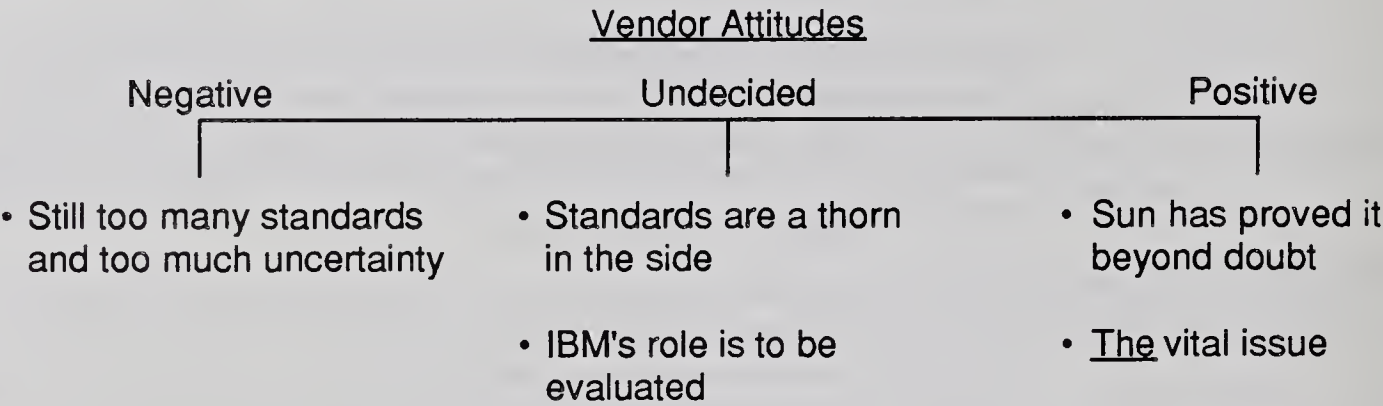
Multisystem conductivity is now becoming a requirement for selling into the corporate computing environment. To implement such a strategy, open system architectures in the form of portable software and standard network interfaces are becoming increasingly important. The success of Sun Microsystems, with its open system computer and network architectures, is evidence of the competitive advantage of such an approach.

Use of standards will become a competitive requirement; which de-facto standards to support is a difficult decision for independent software developers. In particular, it is important to evaluate the new common program interface programming environments, such as IBM's SAA.

The implementation of open systems solutions could also lead to an acceleration in mergers and other types of alliance activity to compete through breadth of product offering. Vendors interviewed by INPUT were overall very positive about the value of open-system computer and network architectures in driving the application software market. Vendors' responses are shown in Exhibit VI-14.

EXHIBIT VI-14

Vendor Attitudes towards Open Systems Architectures



(Above results in response to the question: "Could you indicate on a scale of 1 to 5 the value of open system computer and network architectures in driving the applications software market?")

D**Workstation Software Opportunities****1. Project Management Software**

Most mainframe and PC project management packages have a purely alphanumeric way of entering task relationships with each task given a name and an ID number. All the workstation packages offer a totally graphical interface, enabling the user to create tasks and show relationships on-screen using a point-and-shoot approach.

Project management software designers have realised that the best way to present this complex relationship is graphical. Attempts have been made with both PCs and mainframes, but are invariably unsuccessful due to the smallness of the screen and the speed at which the graphics are drawn. Workstations are the first affordable computers that can offer the speed and the resolution needed to truly present a graphical interface to project management.

The most popular charts are in five categories:

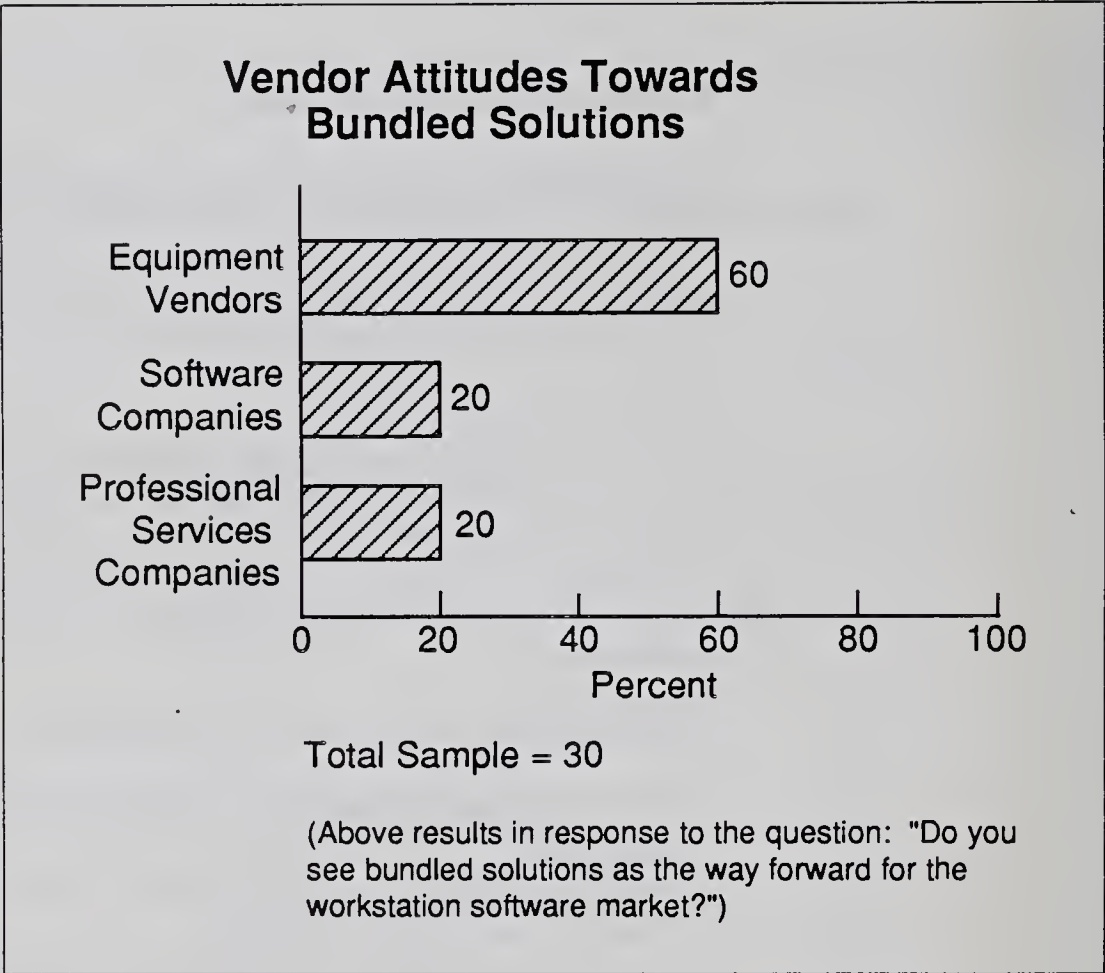
- PERT (Program Evaluation and Review Technique) charts
- Gantt charts
- Timescaled network diagrams
- Resource distribution histograms
- Organisational charts

Newer generations of project management software can be used to support companywide integration and support for several platforms (mainframe, mini and workstation). Such solutions allow for the management of a single project, many projects or all projects within an organisation.

2. Bundled Solutions

IBM's AS/400 4GL/RDBMS, Integrated Financial and Office Applications/RDBMS and IBM's OS/2 Extended Edition are a few examples of the trend towards bundled software solutions, which, as indicated in Exhibit VI-15, is the preferred strategic option of equipment vendors.

EXHIBIT VI-15



There are a number of important issues for independent software developers related to the trend of bundled software solutions. For independent PC communications and database systems software companies, IBM's OS/2 Extended Edition bundled communications and database systems software product offering represents a shift in the competitive structure of these two markets.

New product offerings from Oracle and Walker Systems that closely bundle financial and other applications software with RDBMS solutions are reflective of a significant change in the competitive environment in the financial applications markets for both minicomputer and mainframe products.

3. User Interface Management Systems (UIMSs)

To increase computer usage by promoting system software independence and ease of use, new graphical user interfaces will be incorporated into a number of product offerings appearing over the next year. The developers of these interfaces will also promote their products as standard.

These new products use window environments for multitasking functionality. The newer object-orientated programming languages can help

software vendors create graphical interfaces and thus should gain in popularity as a result of this trend.

Current examples of UIMS products include: MIT-developed X Windows; IBM's Presentation Manager, part of IBM's SAA program; the Macintosh interface; Apollo's Open Dialogue; Open Look from AT&T and Sun Microsystems; NewWave from Hewlett-Packard; and NextStep from NeXT Corp. Such products will significantly enhance the capability for software portability and the development of corporate processing solutions.

4. Computer-Aided Engineering (CAE)

There are two types of CAE software for workstations. The largest category is software that comes from the mainframe software developers that have realised the vast untapped market potential now open to them, but there is also a growing band of software companies that, free from the constraints of compatibility with a previous package, are creating truly innovative products.

The relatively low cost of developing for workstations only also means that these packages can be more vertical—they can concentrate on specific industries such as construction or electronics and provide more knowledge regarding the properties of objects under analysis.

Despite the diversity of CAE applications, over 90% use the same methodology: finite element analysis (FEA). With over 20 years' service on mainframes and minis, FEA has been well-tested, especially when applied to structural analysis. Estimates indicate that there are now at least 25,000 FEA users in Western Europe.

One European vendor commented: "Until now, companies have either had to select a CAD/CAM/CAE system that happens to run on the engineering workstations they already own, or invest in proprietary, standalone workstations which are dedicated to CAD/CAM/CAE. By designing software to run on multiple platforms, you can provide users with a flexible tool for multivendor, heterogeneous CAD/CAM/CAE environments, at the same time laying the foundations for computer-integrated manufacturing."

5. Electronic Design Automation (EDA)

More than 20,000 workstations were sold for EDA (electronic design automation) applications last year. Only four years ago, the hardware platforms for EDA applications were predominantly proprietary hardware produced by EDA systems vendors. Mentor Graphics and Racal Redac were the first to adopt standard Apollo workstations. In 1989, proprietary hardware was replaced almost totally by standalone workstations.

Workstation suppliers have listened to the software producers such as Daisy, Mentor Graphics, Valid Logic, and Racal Redac. The question is, will the workstation suppliers continue to let EDA system vendors dominate the selling of EDA to the lucrative end-user market?

INPUT believes that the marketing strategies of the big workstation vendors are:

Apollo was the first workstation vendor to address the EDA market, relying heavily on its OEM business with EDA system vendors, particularly Mentor Graphics and Racal Redac. Sun has exploited its distributor agreements with major electronic companies such as ICL, Nokia and Toshiba to encourage Daisy, Valid Logic and Racal Redac to port their software onto Sun workstations. Like Apollo, Sun generally relies on EDA system vendors to make the EDA end-user sale.

Hewlett-Packard and IBM have incorporated their third-party EDA software into their product lines and sold it directly on their standard workstation products. Additionally, IBM gave its software an IBM name (CIEDS and CBDS). Significantly, both these companies have been less successful due to their choice of third-party software, and in the case of IBM, the relative-failure of the hardware.

Digital, which began with collaboration with all Digital-based EDA system vendors, has now focused its collaboration efforts on just two vendors, Valid Logic and Racal Redac, and has been more direct in promoting EDA solutions to corporate customers. In the mechanical CAD/CAM area, Digital has recently signed an OEM agreement with Matra Datavision, whereby Digital sells the Euclid CAD/CAM software directly to mechanical CAD/CAM end users. Using this action as an indicator of Digital's marketing strategy in the EDA area, it is reasonable to speculate that a similar OEM agreement for EDA software with Valid Logic or Racal Redac will be forthcoming.

EDA system vendors saw the price/performance of workstations become acceptable around the beginning of 1988. For the top-end workstations based on RISC architecture (such as the new DN10,000 from Apollo), ever-higher levels of processing performance are becoming economic for the more demanding EDA applications such as the routing of large, complex printed circuit boards. However, there remain some problem areas with EDA users continuing to demand new and improved design features. EDA software has become large and complex. With trepidation Daisy, Valid Logic and Racal Redac have ported their software onto a range of workstations. New porting is expensive and time-consuming. For example, Daisy has said that portation amounts to 30% of its research and development costs. The costs do not end on completion of porting. The software needs supporting at both corporate and field level. With each release of the vendors' software and each new version of the workstation operating system, porting has to be effectively redone.

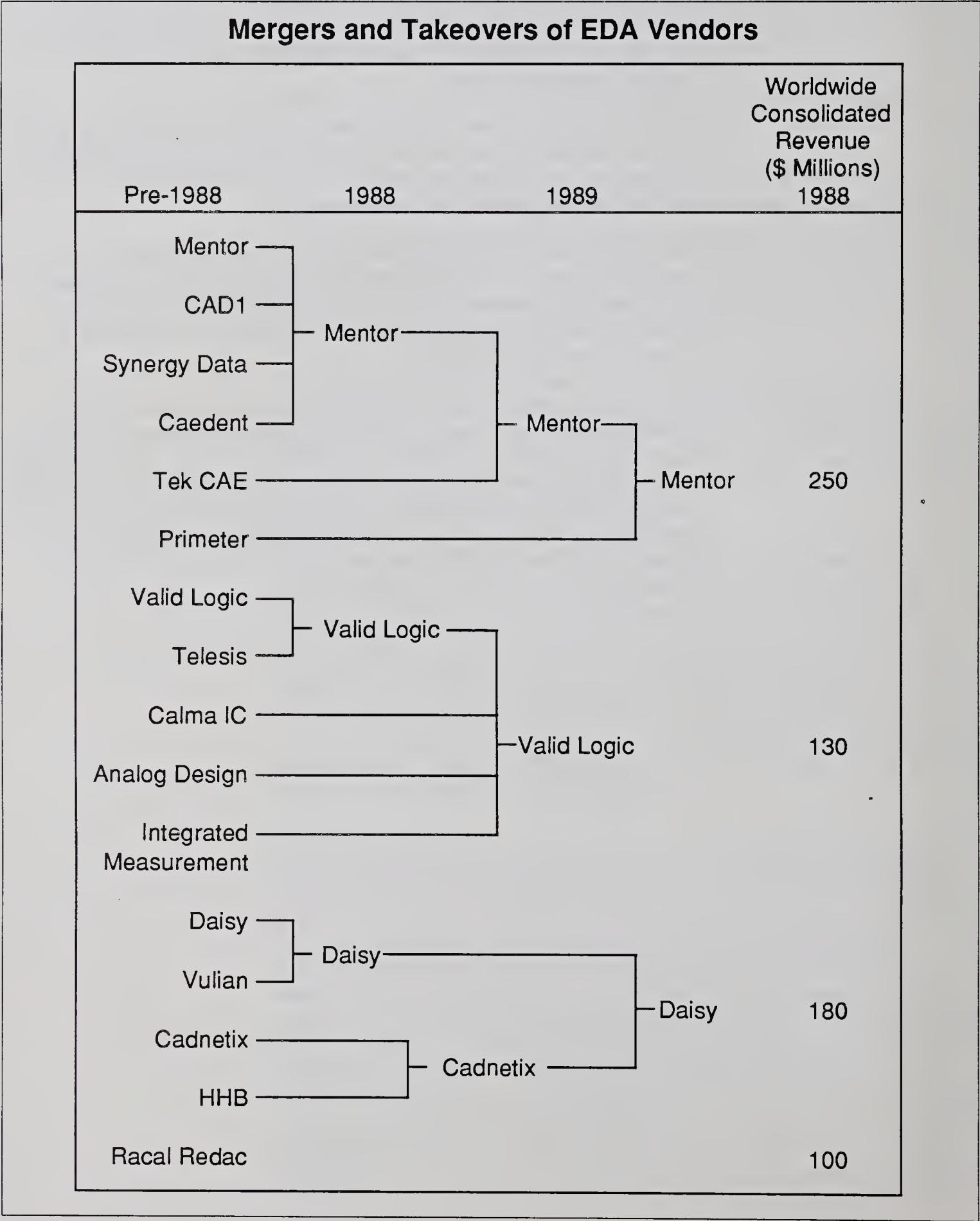
It could be said that some new versions of operating systems with their assorted graphics protocols require as much porting effort as an entirely new operating system. Added to this, workstation suppliers have multiple operating systems and multiple graphics protocols throughout their workstation product ranges.

The principle requirements of end users go through a cycle as the market matures, starting with product features, then ease of use and user interface and ending with product stability. EDA end users now consider product stability to be of vital importance.

End users choose the EDA software first, even when this choice may result in the selection of a workstation that contravenes company purchasing policy. This priority system may change, however, with the growing need for integrated EDA solutions and greater corporate involvement in decision making.

Over the past year there has been a plethora of mergers and takeovers among EDA system vendors in order to reprovide integrated EDA solutions. These activities are summarized in Exhibit VI-16. Mentor Graphics, the EDA systems leader, set the scene in early 1988 by differentiating itself as the only vendor to offer a totally integrated product line. From that point on there has been a merger/takeover every month, as vendors fill gaps in their product lines and invent new niches to differentiate themselves.

EXHIBIT VI-16



Mentor Graphics, Valid Logic and Daisy have emerged as the main EDA suppliers. Racal Redac, although dominant in Europe, is now trailing the three leaders. However, it may soon be able to acquire other software companies with the influx of cash into Racal Electronics from the sale of shares in Racal Telecomms.

Is an integrated EDA solution mainly hype or a real market need today? The hype is certainly raising EDA users' awareness of integration. The major need is predominantly from the major electronics companies. How does the drive towards integrated EDA solutions affect the workstation companies? Electronics companies have not been slow to realise that the benefits of the integrated EDA solution are more meaningful at a senior management level in large corporate accounts. Decision making is moving up to the corporate level where large companies like IBM and Digital are more at home.

The corporate market for EDA is a major opportunity for workstation suppliers. It is reasonable to speculate that workstation vendors will want to consolidate their increasingly exclusive relationships with Mentor Graphics, Daisy and Valid Logic, but maintain a relationship with Racal Redac for the Western European market. Digital will likely seek to become an OEM for Valid Logic's products, to complement its marketing strategy with Matra Datavision in the mechanical CAD/CAM market.

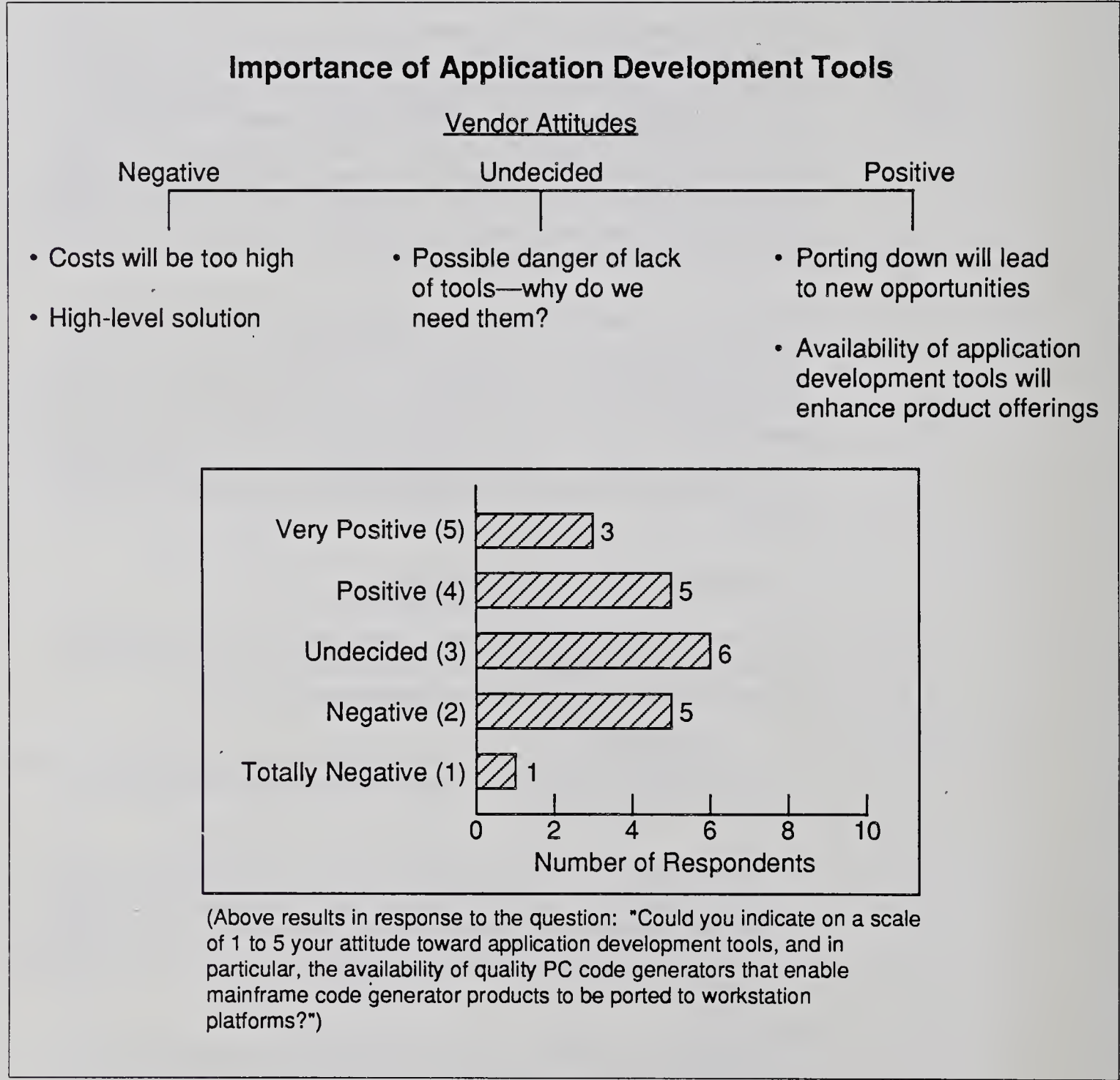
6. Application Development Tools

There are a number of new-product developments in the application development tools market that will significantly enhance the growth prospects for this market over the forecast period:

- The availability of quality PC code generators and compilers is making it possible for traditional mainframe code generator products to be ported to PC platforms.
- Neuron Data's NEXPERT OBJECT expert system development environment allows for the development of knowledge-based, embedded intelligent solutions with cross-platform portability for the Macintosh, PC AT and PS/2, Sun Microsystem, Apollo Computer and VAX/VMS platforms.
- The number of integrated (front- and back-end code generation) product offerings with fully integrated data dictionary and project management capabilities is increasing.
- Reverse engineering CASE tools, which utilise the advanced capabilities of the data dictionaries/repositories, have also been announced by some of the integrated CASE suppliers.

Vendors’ attitudes to application development tools are summarized in Exhibit VI-17.

EXHIBIT VI-17



CASE tools are used for analysis, specification, design, simulation and code generation of complex application development. CASE tools are designed to produce software correctly the first time they are used, thus saving time on patches and revisions.

There is general agreement that the cost savings as a result of CASE will not show up on the corporate balance sheet within the first two years. In fact, initial expenditure for CASE software and training, as well as inexperience with CASE, will actually raise development costs in the short term. Despite these problems, software developers will have to turn to CASE to keep pace with the steady stream of new hardware introduced. If developers don't, powerful new workstations will continue to be produced, and will then wait for applications to be developed to exploit their real capabilities.

The following are some of the leading CASE products currently available for UNIX workstations.

- Excelerator is a specification and analysis tool that runs on Sun, Apollo, VAXstation and IBM PC platforms. Excelerator is technique-independent and does not force one methodology for all applications.
- Interactive Development offers the Software through Pictures family—separate modules that use structured analysis and design. Software through Pictures runs on Sun, Apollo, HP, VAXstation and PCs running OS/2.
- Mentor Graphics offers a set of front-end tools designed for the development of real-time systems. Using structured analysis techniques, the Analyst/RT product can simulate trade-offs between hardware and software. Mentor Graphics' tools run on Apollo and VAXstations.
- Oracle's CASE Method is one of the few UNIX CASE tools to be aimed at MIS applications. CASE Method combines structured analysis with information engineering techniques. CASE Method runs under X Windows on Sun, HP 9000, VAXstation and PCs running OS/2.
- Reflex Technology is the sole U.K. distributor of a suite of CASE tools from Visual Software. The tool set includes drawing and symbol editors, a word processor, a report generator and virtual display.
- Semantics offers a system called the Visible Analyst Workbench. The centre of this system is the Visible Prototyper, which gives integrated applications prototyping and simulation capability. VAE runs on IBM PCs and compatibles.

- The Teamwork product family from Cadre Technologies consists of a set of analysis, design and configuration management tools with extensions for real-time development also available. The Teamwork products are based on a combination of structural analysis and object-orientated methodology. Teamwork runs on Sun, Apollo, HP9000, VAXstation and PCs running OS/2.
- Cocad's PROSA is an advanced computer-aided SA/RT tool that operates on Sun, Apollo, VAXstation and the IBM PC. It helps in visualising, specifying, designing and managing system and software development projects.
- IPL has developed a testing tool called SOFTEST, which automates unit and integration testing. SOFTEST closes the gap between code generation and system acceptance. SOFTEST runs on Sun, HP9000, Apollo, DEC VAXstation and PCs.
- Eiffel, from Interactive Software Engineering (ISE) is an object-orientated design package that generates code in C++, which in turn can generate C code. Applications include software engineering, MIS and simulations running on Sun, Apollo and 386 PCs.

7. Object-Orientated Technologies

Object-orientated computer technologies could become one of the most significant new software technologies over the forecast period. A product of the artificial intelligence world, object-orientated technologies are becoming part of a number of more mainstream computer applications.

Object-orientated technologies include object-orientated programming languages and object-orientated data/file structures. Objects represent physical entities, abstractions and processes that are classified by inherited attributes.

Object-orientated programming technology comes out of the traditional AI languages (Smalltalk, LISP, PROLOG) environment. The original Smalltalk language also represents the origins of the Macintosh interface.

These object-orientated programming languages are gaining in popularity, particularly in the higher education market for teaching AI technologies, as well as among application programmers for developing proprietary graphic-orientated user program interfaces.

C languages, with developed object-orientated extensions such as C++ and Objective C incorporated into the NeXT workstation, are also becoming mainstream AI programming languages.

The incorporation of an object-orientated C language in the NeXT computer and the NextStep user interface could be a significant catalyst for bringing object-orientated programming into the mainstream computing technology. The Objective C language bundled into the NeXT workstation was licensed from Stepstone.

In addition to helping to develop easier-to-use application interface structures that can also enhance software portability, object-based languages along with object-orientated database architectures also provide the capability for integrating sound, data, voice, text and video into common information management structures by virtue of multiplier inheritance structures in programming multimedia applications and database structures.

8. Mapping Software (GIS)

The geographic information systems (GIS) market, which involves the conversion of databases into map presentations, is one of the fastest-growing components of the market for computer graphics applications.

GISs have seen much activity in Europe over the past two years because CPU power and storage prices have come down. Particularly important as the main problem for GIS manufacturers is the volume of data to be stored and processed.

Arc/Info distributor Doric Systems, for example, sold four times more systems in the first quarter of 1989 than in the whole of 1988. The GIS market worldwide is growing 35% per annum. Currently worth \$2–3 billion in the U.S., the market is worth \$750 million in Western Europe.

At the heart of every GIS is a database. Companies can build their own databases of information from the third-party organisations. About 80% of GIS users are running the software on workstations, usually Sun or Digital. Although the software can be run on a shared computer, in the end the software is better off on its own system. This preference doesn't mean users have to throw away old computers—software can be written to link with, for example, Arc/Info.

The cost of Arc/Info on a PC/workstation is £3,500–£7,000. On a mini or a mainframe, Arc/Info would cost between £45,000 and £100,000. The growth market at the moment is (not surprisingly) the lower end.

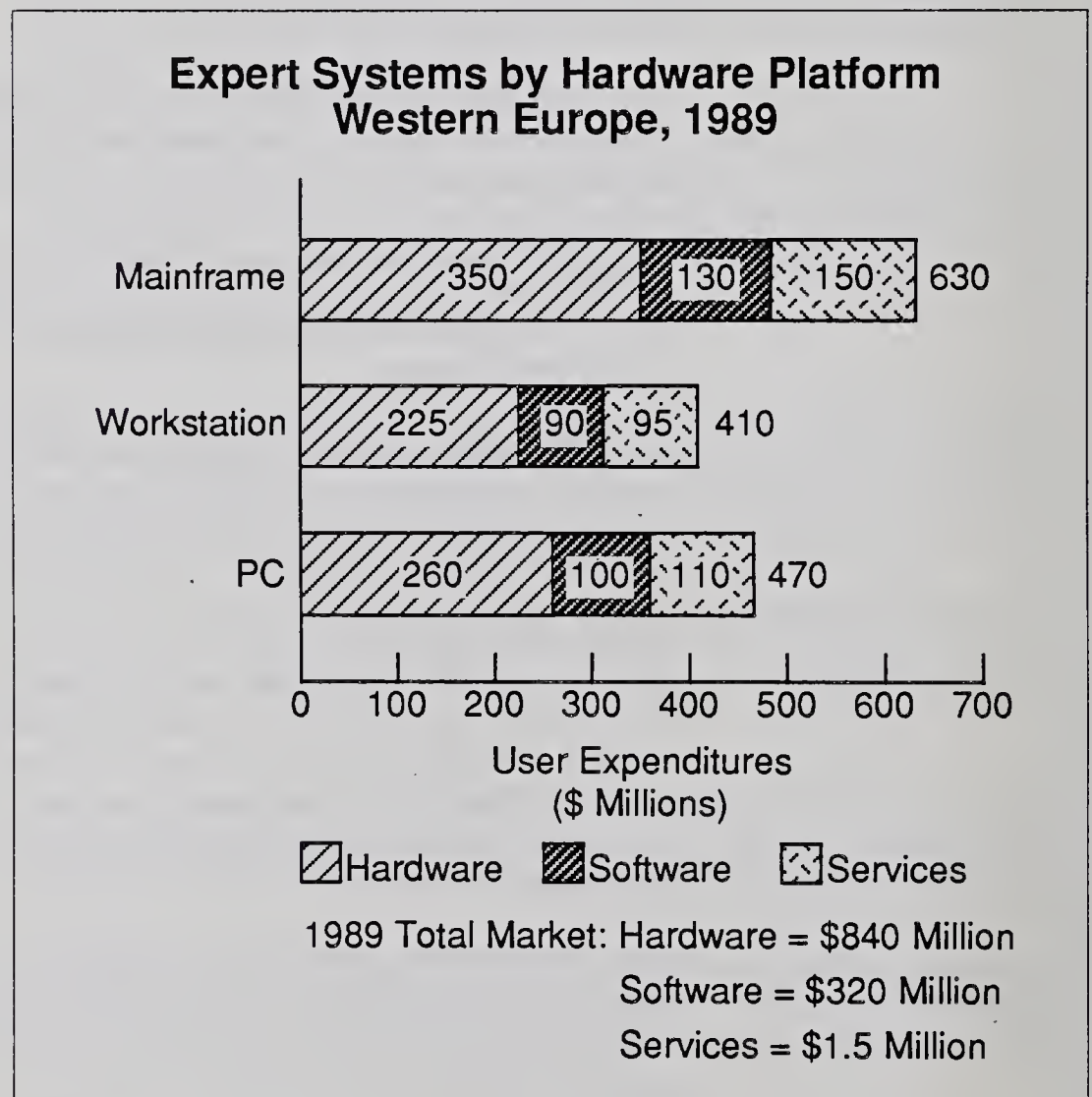
ESRI's Arc/Info is the accepted market leader in GIS software. It has a turnover of \$40 billion a year. Arc/Info combines and manipulates geographical data from maps and information from numerical data tables that users build themselves.

Intergraph is hot on ESRI's heels. Intergraph started as a CAD and automated mapping company and now wants to make it big in GIS. Laserscan of Cambridge is a force in the U.K.; IBM's GFIS product is not highly regarded.

9. Expert Systems

The expert systems market by hardware platform is shown in Exhibit VI-18. Expert systems shells are essentially CASE tools designed specifically for developing expert systems. Expert systems typically comprise a friendly user interface, a knowledge representation language that defines rules in the knowledge base and an inference engine that uses expert knowledge to solve problems by reasoning.

EXHIBIT VI-18



The most popular platform for expert systems is the IBM-compatible PC, but mini and mainframe computers from Digital and IBM follow closely. Specialised LISP workstations account for 10% of AI hardware sales in Europe, compared with 20% in the U.S. A full breakdown is given in Exhibit VI-19.

EXHIBIT VI-19

Expert Systems Hardware Platform Comparison—Western Europe and the U.S.

Platform	Distribution of Expert Systems 1989 (Percent)	
	Western Europe	U.S.
IBM 370	19	17
DEC VAX	18	15
Other Mainframes	5	4
LISP Workstations	10	20
Engineering Workstations	15	15
IBM PCs	30	25
Apple Macs	3	4

INPUT estimates that Western European users spent almost \$1 billion on expert systems development in 1989. U.K.'s spending on the defence sector was far higher than its European counterparts, accounting for almost 25% of U.K. expert systems expenditure. The manufacturing sector represents 40% of the West German and 35% of the French expert systems expenditures. Users will spend in the region of \$5 billion on expert systems development in 1994.

E

User View of Application Requirements

1. The Business Market

An example of the importance of the business market is that the business software section of Sun's Catalyst catalogue is the most rapidly expanding section. Almost every day, news comes in of a software company planning to port its office product onto X Windows, which is rapidly becoming the standard graphical interface for workstations.

Most office UNIX software tends to be written for lowest-common-denominator user interfaces. However, the success of X Windows on workstations, PCs and now minicomputers is giving the application a

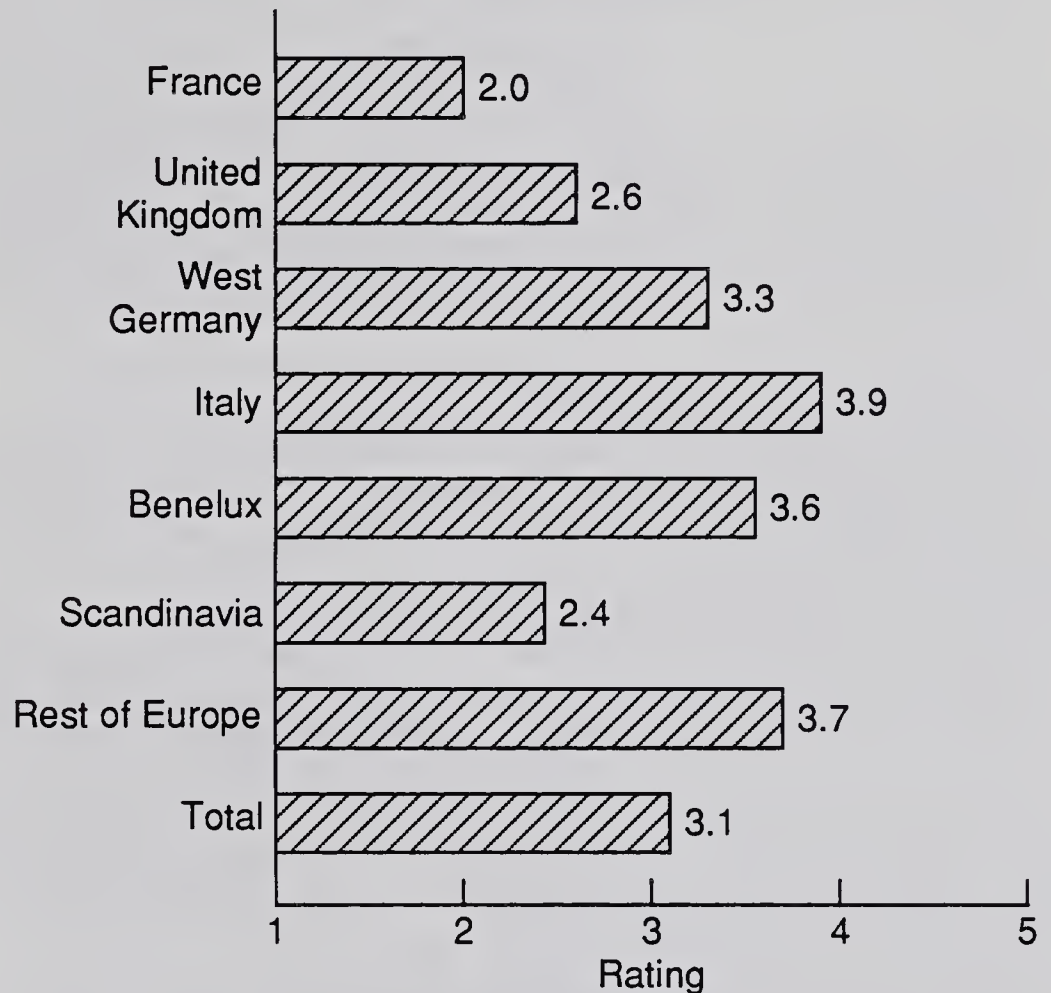
common graphics and database standard. Four of the best UNIX office products now available (i.e., those with full office functionality, word processing, E-mail, calendar, spreadsheet, graphics and database capabilities) are the following:

- Applix's Alis is renowned for its graphical interface and for its compound document architecture.
- Quadratron's Q-Office+ is the best-known office package for the UNIX environment. However, Uniplex is challenging its position as part of a number of deals with VARs.
- Uniplex's Advanced Office Systems' strength comes from the integration of the modules rather than its friendliness.
- Informix's SmartWare is one of the most popular integrated word processing, spreadsheet and database suites.

INPUT's user research, illustrated in Exhibit VI-20, shows the strength of the user need for office automation. Buzzwords in the environment of integrated software during the next few years will be *objects* and *object-orientated*.

EXHIBIT VI-20

Strength of User Need for Workstation Application Software, Western Europe Office Automation



Total Sample = 200 Users

(Above results are in response to the question: "If the applications existed for office automation, would you consider moving them to workstations?")

As discussed earlier, UNIX workstations are likely to become the dominant computing platform, overtaking the PC and the mini. Although the success of the workstation has impacted technical and graphical business applications, it has not made much impact on mainstream business databases. Ninety percent of business applications are basically customised database applications.

In order to address these applications, it is important to offer not only the database mechanics but also an intelligent programming environment in

which to use them. 4GLs, though initially claiming to solve practically all programming problems, have now settled down into the role of business application generators. However, only a small percentage of the UNIX 4GLs available for minicomputers have been ported to workstations.

Furthermore, there is a blurring between 4GLs and CASE. In general terms, 4GLs are aimed at quickly generating business applications for general internal use. CASE, on the other hand, is the use of computers to control the development of very large, complex and probably commercial applications by using engineering principles. In short, with 4GLs the user can generate results very quickly, whilst CASE tools may require up to a month's training just to learn how to use them.

2. 4GL Products for Workstations

A large proportion of the available 4GLs come from database manufacturers. In many cases, the database programming language has become so sophisticated that it has been unbundled and sold as a separate product.

- Accell is the 4GL offered by Unify, manufacturer of the Unify database. Accell is a powerful application generator, but for the more complex operations a more traditional programming language is supplied, with excellent links to the application generator. The most popular feature of Accell is the ability to work in a multivendor environment. Although Unify offers only a database for the bigger minis, the Accell user interface is available for PCs running Microsoft Windows and will soon be available (1990) under X Windows for the major UNIX workstations.
- Ally, from Foundation Computer Corp., is designed to run in conjunction with Oracle, Unify or any database conforming to the C-ISAM database standard. Ally has been resold by Digital for some years and development has not been for DEC VAX stations.
- Dataflex is perhaps the most popular 4GL and DBMS (database management system) for OEMs and VARs. Dataflex is probably the most CASE-like of the 4GLs available, relying almost entirely on mouse selection to operate.

The Dataflex 4GL is a complex programming environment complete with real number variables and considerable graphics capabilities. The arrival of X Windows means that at the start of 1990 Dataflex will be a fully fledged X Windows application with pop-up windows and pull-down menus. Even though Data Access Corporation is dedicated to the success of X Windows, it is still offering an OS/2 and Presentation Manager version of the product.

Foremost in Data Access's plans to conform to the leading workstation standard is the ability to produce a very transportable product. More than any other organisation in the workstation market, Dataflex understands the standards issues and the potential they offer. Since the beginning of 1989, Dataflex has offered conformation with SQL (Structured Query Language) and work has started on offering compatibility with other systems.

- Focus started life as a mainframe 4GL designed to operate on any database file that can be converted to a text format. Focus is available as a text-only application on Sun, Apollo, Digital and HP platforms. Focus' greatest strengths are its ability to collect old databases and form them into one usable system and the decision support system it incorporates.
- Informix' 4GL is a serious programming language that produces C code that then needs compiling via a third-party compiler. The need for a separate C compiler means that Informix is an expensive 4GL but a very flexible one. Informix is keen to promote the product for general office automation and DBMS systems, especially since its acquisition of Innovative Software (the manufacturers of the Smart integrated software collection). Informix is available now in terminal form for UNIX workstations. There are no plans for X Windows until customers are using it in business environments (a significant declaration).
- Ingres is one of the oldest 4GLs available and was the first non-PC 4GL to offer query by screen-painted forms. Ingres is basically a 4GL built around a data dictionary; this gives it some unusual abilities, such as being able to locate all applications using particular files. Ingres has had an agreement with Sun Microsystems since late 1987, meaning that almost all of the Ingres 4GL system is available in Sun Tools' graphical interface. Ingres is also available for the Unify database using the same graphics as Unify uses. Other than the agreement with Sun, the majority of Ingres development has been centred around multiprocessor, multivendor networks.
- M-Builder is offered by Empress for use with Empress DBMSs. One feature is its ability to support arbitrarily long data strings, which in turn has made it a good choice for graphic input devices such as scanners. Given such capability, it is surprising that Empress offers no facilities for exploiting the graphics of workstations.

User reaction to this new generation of 4GLs tends to veer towards the argument that it is easier to keep the same database and change toolsets. Some observers question whether the database companies that have uncoupled their 4GLs from the basic database will be hurt by this strategy. One reason that damage is unavoidable is that the database companies have been developing front-end/back-end models that conform to a

specified standard. Once these models are available, anyone who conforms to that standard can work with other products.

Unbundling 4GLs from databases also lets manufacturers target different markets, such as large mainframe markets. Informix, for example, already produces its tools for the two main large-system databases, DB2 and RDB. In the case of DB2 and RDB, IBM and Digital simply aren't supplying 4GLs. A significant number of users are committed to using these products.

The companies that are uncoupling their 4GLs are doing so for a variety of reasons. Companies like Informix and RTI would like to get a foot in the door of the IBM- and Digital-orientated MIS departments by putting their 4GLs in as many hands as possible. Smaller companies such as Unify are pursuing the strategy because it appears to be their best option if they are to continue to expand.

The 4GLs summarised above are only a small percentage of what will be available for workstations during 1990. Most of the manufacturers are aware that one of the most important factors in selecting a 4GL is the ability to run on different machines.

3. CAD/CAM

The problem with CAD/CAM is that although half of the manufacturing companies surveyed have bought CAD/CAM systems, few use the systems properly. CAD/CAM systems are frequently installed to automate rather than to be an enabling tool for better design and review procedures.

There are over 500 different CAD systems on sale in Western Europe. Three basic types are in use:

- The mainframe type of system supporting a number of graphics terminals
- The microcomputer—usually a standalone desktop machine
- The engineering workstation, connected in a series as a kind of ring main

Of the three options, the workstation platform offers the most advantages, as shown in the summary below.

- Mainframe:
 - Advantages: Puts the power of a mainframe computer at the disposal of a team.

- Disadvantages: The initial machine and software costs are so great that it is difficult to obtain an adequate return on capital no matter how fast the facility runs.
- Micro-based:
 - Advantages: Offers a low-cost entry point to CAD, and, although slow, enables the user organisation to sample the technique.
 - Disadvantages: Relatively slow on large projects with redraw etc., and may give a false impression of the software or even CAD itself.

Machines are one-person, one-terminal. Machines are difficult to share, but the data cannot be readily shared either. It is very difficult to make data used once over a CAD system pay for itself (and one of the benefits of CAD is that data must be generated only once).

- Workstations:

One of the advantages of workstations is that, although more expensive than micros, they are cheaper to run. Each has a processor on board and shares a disk or a series of disks. Workstations are able to communicate directly with a neighbour so that systems are shared. The network is the computer and the method of sharing data is handled already by the manufacturer before the equipment is installed. The user can add terminals to the system nodes.

The machines start as pure networked drawing engines. They are not ordinary computers that have been customised to enable them to be used for drawing—they can draw very well from the beginning.

One vendor, VersaCAD, after three years of concentrating on distributing VersaCAD computer-aided design software, has changed tactics to maximise its impact on the market. The strategy involves providing the total solution system to its customers rather than individual packages. The company's belief is that the most successful and satisfied customers have been those provided with total solutions. As a result, VersaCAD will be producing its own turnkey systems, that will have overall control and can decide which is the most suitable hardware for clients to use in conjunction with VersaCAD products.

4. Accountancy

Accounting/business systems form the largest sector of the Western European software market, with over 1,000 packages.

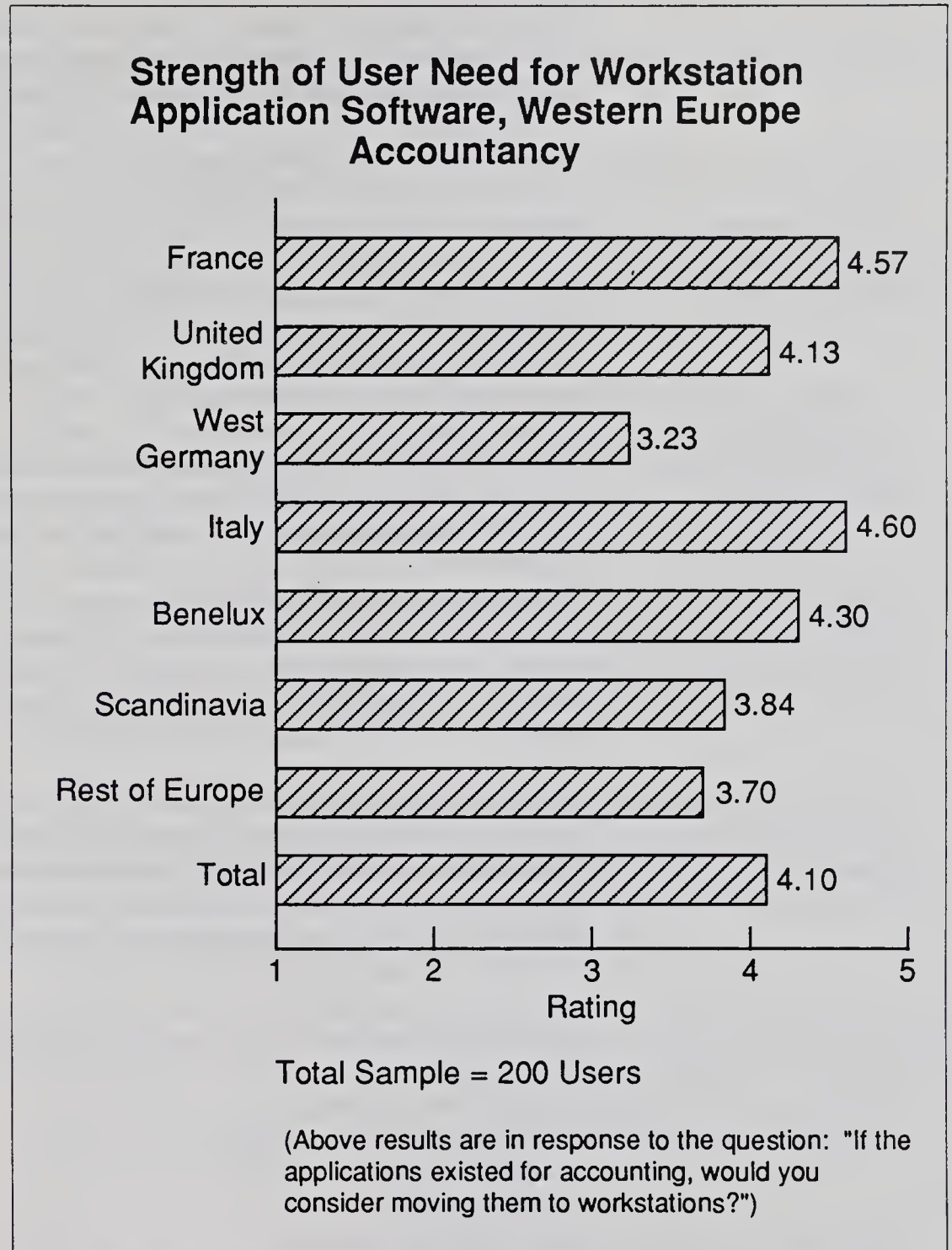
However, only a few suppliers offer general-purpose packages through dealer channels; the vast majority being developed are “bespoke” to

individual clients' requirements by the software author. Pegasus heads the DOS market, with Sagesoft second. In the multiuser UNIX environment, two other U.K. companies predominate: Tetras (with Tetraplan) and Chameleon have established themselves as clear market leaders. Multisoft follows, with its Standard and Premier packages. Three-quarters of all accounting packages run on DOS or UNIX.

The trend towards the greater use of PCs as workstations will continue. However, until the reliability problems inherent to distributed DP are solved, most accounting data will continue to be stored and processed centrally on mainframes.

As can be seen in Exhibit VI-21, there is a high level of response from end users with regard to planning accountancy applications on workstations. As more software becomes available, this trend will be irreversible.

EXHIBIT VI-21



5. Banking and Finance

Workstations are present in the dealing room, three years after the "Big Bang," but the technology is still regarded with some suspicion. Readily apparent is the gap between the systems installed before the Big Bang and those available now. A second obvious feature is the return of the mainframe in the form of a supercomputer. The powerful centralised processing capability of supercomputers installed at Reuters and Telerate is difficult to emulate despite suggestions that a network of workstations should match it.

The importance of desk and screen layout is playing a part in the selection of systems. The amount of data passing through a dealer's desk per day is substantial and the effects of bad layout can cause problems. Initial systems were purchased on the basis of processing capability, thus resulting in several screens and keyboards. However, it is in this area that the workstation is making its greatest impact with its capability of displaying all the necessary information on a single screen.

The most common complaint of multiscreen PC solutions and single-screen workstation solutions is a lack of logic in data presentation. Video switches and direct digital feeds are solutions, although integration with other dealing-room technology is still to be perfected.

Two years ago, the average financial information specialist would almost certainly claim that dealing room systems were unique among computing solutions and needed heavily modified hardware. Now that the market has matured, the importance of standards is having an impact. The insistence on custom solutions was more of a status thing than a necessity and resulted in excessive cost. The uses to which these workstations are put are fundamentally the same as those of the PC: to talk to a centralised processor, be it a mainframe or a supermini, that acts as a coordinator for all the dealing room information.

Workstations are no longer expected to replace the central processor—not so much because of the security implications, but because of the workstation's conductivity with other computers, making integration easier than replacement. The central processor will monitor the risk of the whole dealing floor, expose inconsistencies between individual dealers and generate gap and profit reports.

There are four tasks a dealing workstation should perform:

- Information abstraction
- Central processor interface
- Decision support
- Data capture

As far as functionality is concerned, there is a gap between the information providers and the software to deal with it. The Reuters and Telerate information systems offer a degree of sophistication rarely exploited by most dealers. Few dealers complain about the quality of information or the speed at which it is provided. Being competitive systems, the two systems are not compatible and no plans are underway to make them so. Probably one of the biggest growth areas for independent software developers is integration of these two services.

Another important facet of any dealing room workstation is the quality of its interfacing. The speed at which deals are reported to the electronic

back office is crucial to the success of the floor. The final objective is to have a system that displays all the relevant counter-party deals on screen by the time a dealer makes telephone contact.

A noticeable trend is the number of third-party packages aimed at filling gaps in the original specification. This is the most dubious area of the business, with no shortage of "cowboys" repackaging standard PC utilities and selling at many times the original price. Nevertheless, there is no shortage of dealing rooms that cannot survive without them, especially in risk-analysis applications.

The most popular third-party packages are connected to the options market. There are at least five established ways of calculating option pricing and perhaps fifty variations, which are all highly mathematical. Most general-purpose dealing room systems make no special provisions for options, often leaving such provisions to desktop calculators.

Another successful application often sold in third-party form is market comparison. Cash positions are usually closed by the use of off-balance-sheet markets. A computer program can be written that monitors both and converts the quoting system from one to the other for ease of comparison.

Charting, an alternative strategy for portfolio investment, is playing an increasing role in all dealing-room systems; the more powerful UNIX workstations are revealing new ways of displaying complex relationships. There is no doubt that charting is one area in which dealers will reap the benefits of full-blown workstations, rather than PCs.

The final area to be considered is deal capture. Once a dealer has assessed the market data, checked the availability of market limits and used decision support tools, the next step is to perform the trade. Via Reuters direct dealing, a telephone link or a broker, the dealer will have committed his institution to a substantial transaction. It needs to be recorded quickly and accurately.

How this is done depends on the type of market. There are touch-pads for the foreign exchange and traded options markets, with the touch-pad sending a predefined string of data to the workstation, which then sends it to the central processor. More complex markets, such as futures, can be entered only via a keyboard. The form design and error-checking applied is painstaking but essential, because a mistake can be very costly.

The exact method of transferring the data is unimportant. The dealer needs to know how the transaction affects his or her personal position and that of the organisation. At the same time, management needs to know the positions and exposures for the room overall. Thus, the workstation

must rapidly update the consolidator and there must be a very secure lock-out system so that no two dealers can perform conflicting transactions simultaneously. Although decision support and data capture are most definitely two discrete applications, they are often combined into one application.

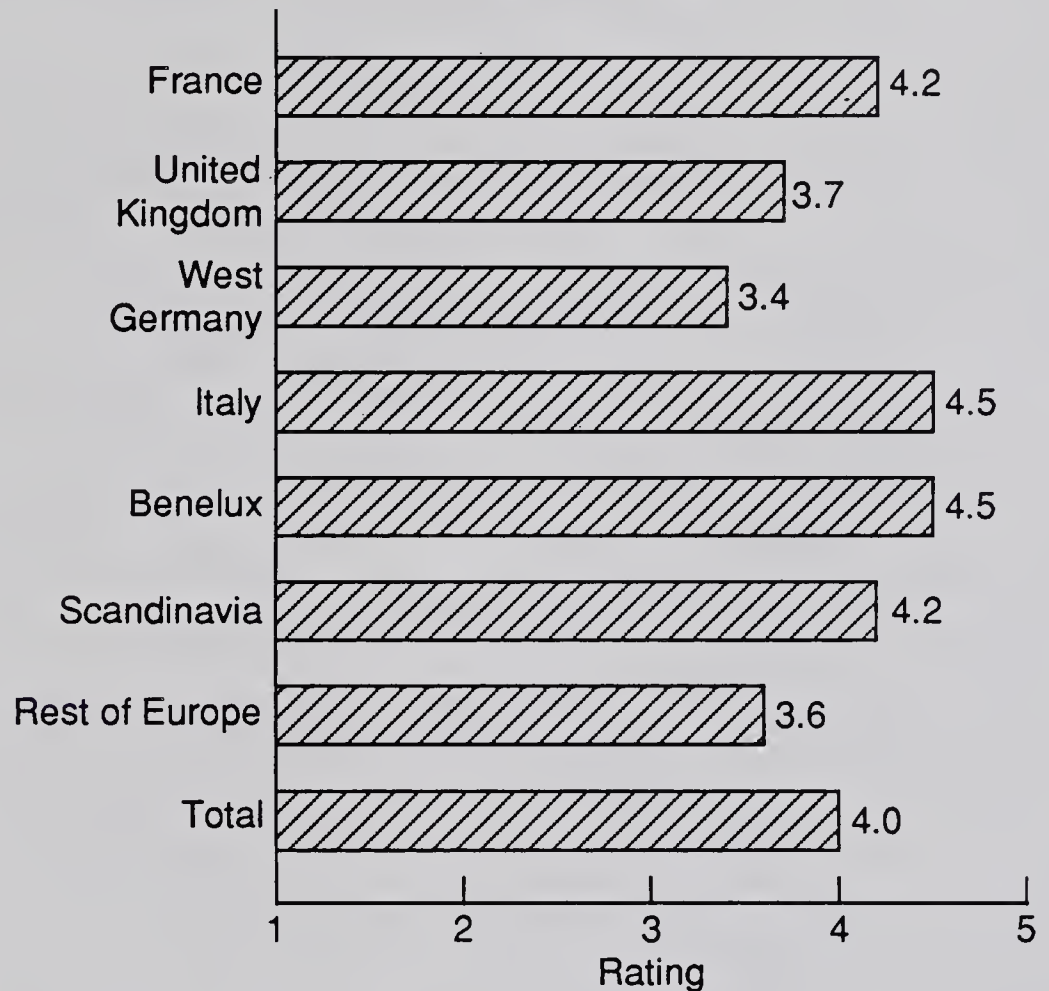
One problem with the introduction of UNIX workstations into the dealing room is that different software companies have used them to extend different aspects of a total dealing system. The information providers have used them to extend the ways in which their services can be displayed. The big players like Micrognosis have similarly concentrated on new areas of visualisation, such as three-dimensional charting.

The suppliers of smaller third-party solutions have rather concentrated on the raw processing power now available to them, making risk calculations even more sophisticated. Suppliers will adapt to standard graphic interfaces only if their sales are threatened. The big banks are still very data-processing-orientated and are the farthest behind in supplying local processing support programs.

Overall, the development of the true multipurpose dealer workstation is still some way off, but the rapid acceptance of UNIX workstations over the PC at least means that the hardware capabilities have finally arrived. Certainly in the overall banking and finance area, INPUT's user research recorded higher results overall for the strength of user need than for the other key application area of planning and analysis. These results are listed in Exhibits VI-22 and VI-23.

EXHIBIT VI-22

Strength of User Need for Workstation Application Software, Western Europe Banking and Finance

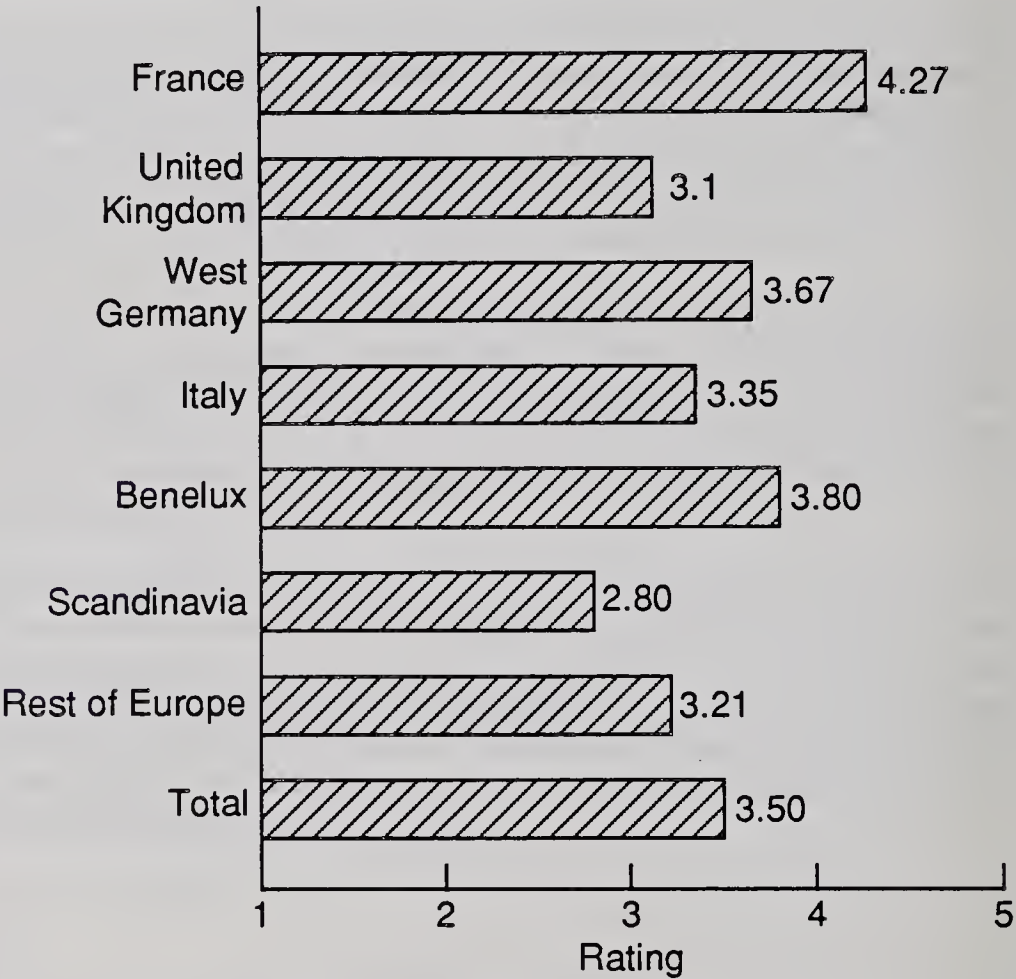


Total Sample = 200 Users

(Above results are in response to the question: "If the applications existed for finance, would you consider moving them to workstations?")

EXHIBIT VI-23

**Strength of User Need for Workstation
Application Software, Western Europe
Planning and Analysis**



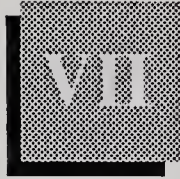
Total Sample = 200 Users

(More results are in response to the question: "If the applications existed for planning and analysis, would you consider moving them to workstations?")



Marketing Challenges





Marketing Challenges

A

Strategic Issues

1. Mergers/Acquisitions

Merger and acquisition activity, along with strategic alliances, has continued to accelerate over the past few years. The following are some of the mergers and alliances that have taken place within the industry:

- In 1987 Informix acquired Innovative Software, a developer of integrated office automation software (the Smart suite).
- In 1988 Apple acquired Orion Network Systems and Network Innovations, developers of communication software solutions.
- In 1988 Oracle bought Falcon Systems to strengthen its image-processing product line.

The fast-growing electronic design automation (EDA) market is highly competitive because of its relative maturity and the acquisition of computer-aided engineering company HHB Systems Inc. by Racal Redac Group Ltd, following several mergers and acquisitions by market leaders Daisy/Cadnetix, Mentor Graphics and Valid Logic Systems.

Bought by Racal Redac for \$19 million, HHB provides Racal with an improved computer-aided engineering capability, consolidates its future in the simulation market and brings important distribution channels in the U.S.A.

HHB is the first in a series of acquisitions meant to draw new products, distribution and service outlets into the Racal group. Up to now, computer-aided engineering sales have represented only about 20% of Racal Redac's revenues. One immediate consequence of the ownership is the integration of some development programs, leading to a new range of

chip design tools—in particular, a virtual hardware description language capability added within its electronic design automation product environment.

A condition of the sale has been that Daisy will still take HHB products via an OEM agreement; INPUT anticipates that more such OEM deals will be struck between vendors in 1990. For example, in this instance HHB offers a range of computer-aided engineering tools, the best-known of which is the Cadat logic simulator package for printed circuit board and application-specific independent circuit design. NEC uses Cadat on approximately 300 chip designs a year. Products from Racal Redac and HHB are already compatible—work on integration has been going on for the last four years under the terms of an existing OEM agreement in which Racal bought the Cadat package. Both products run on MS-DOS and VAX systems, 80386 UNIX boxes and the RISC machines from Digital, Sun and Apollo. Sales to Racal Redac represented 17% of HHB's total revenue last year.

INPUT estimates that the revenue of the combined operations of the two firms will be around \$90 million for the year. The CAD/CAE market is said to be forging ahead with growth rates of 30% a year or more, the printed circuit board market a less impressive 15%. Racal Redac claims a 40% growth rate in its business to Japan and 9,000 installations worldwide.

Racal Redac also reports that it has added Visula Plus to its Visula CAD/CAE/CAM suite. Visula Plus enables printed circuit board designers to take advantage of multiple “panel” manufacturing strategies in which boards are made in multiple quantities on one sheet of laminate (known as a “panel”) rather than singly.

2. Alliances

Alliance activity, including the development of strategic relationships, joint development efforts and co-marketing activities, has been particularly active over the past two years. Examples are:

- Sun and Apollo supply and support network software and services to other vendors that provide a proprietary product but want to connect their proprietary products with Sun or Apollo workstations.
- Sybase and Verity announced joint-marketing agreements for their RDBMS products and Verity's document search and retrieval software program.
- Apollo and MacNeal-Schwendler Corporation (MSC) recently announced a joint marketing agreement to make MSC/Nastran the engineering market's most widely used structural analysis package.

- Lotus has agreed to develop products for Sun's three computing platforms: the SPARC-based workstations, the Motorola 68000-based Sun-3 line and the 80386-based Sun 386i.

The absence of general business application software has kept Sun from making significant inroads in all but the power-hungry financial community. This alliance is a good fit for both companies: Sun aligned with a company famous for general application software, including the best-selling 1-2-3 spreadsheet program, and Lotus enters the running for lucrative government contracts that often require UNIX compatibility.

With software driving the market, the strategic agreement signed between MIPS Computer Systems, Network Computing Devices and the software company Visix could be illustrative of a trend in the nineties. Visix is looking for its Looking Glass software to be accepted as a de-facto industry standard, and MIPS and NCD benefit from being able to better demonstrate their products.

Looking Glass is an icon- and mouse-driven graphical UNIX interface that runs on graphical workstations and X terminals. Implemented in conformance with the OSF Motif look-and-feel standard, Looking Glass' graphical interface offers users an intuitive method of managing files and directories, manipulating the UNIX environment and launching applications. It provides the final layer of system interface software needed to make UNIX a complete end-user product. As a result, both MIPS and NCD are presenting Looking Glass as the graphical shell of choice for their UNIX systems.

Alliances are key to the goal of establishing a common platform for distributed computing. Sun's alliance with Netwise and Novell has resulted in a solution that simplifies the creation of distributed applications that will run without modification across a wide range of operating systems, hardware architectures and network transports. The result is software developers will be able to build and distribute to their customers a single, shrink-wrapped software package that will run on many PC LANs and interact with software on other computers running other operating systems and connected into different types of networks.

Significantly, this move has won the support of several leading software developers and system vendors, including Ashton-Tate, Banyan Systems, Informix, Interactive Systems, Lotus Development, Relational Technologies, 3Com and Unify. Sun's "Five-Phase Plan" is included as Exhibit VII-1.

EXHIBIT VII-1

**Sun Microsystems' "Five-Phase"
Plan for UNIX Workstations**

1. Encourage vendors to build binary-compatible instruction set chips.
2. Increase number of licenses for Sun's operating system.
3. Work with equipment vendors to build UNIX-compatible SPARC architecture workstations.
4. Encourage key software developers to port to UNIX/open look.
5. Ship SPARC-compatible systems in volume.

Vendor attitudes could be summarised as follows: The development of distributed applications has been hampered by a lack of standards for mixed-vendor networks. The industry is now moving into the era of client-server network computing.

A different type of alliance, but one that INPUT expects to become a standard approach as the market matures, is a new partnership that will focus on medium-sized manufacturers. This type is being established by ICL and is known as a "Computers in Manufacturing" partnership that aims to offer specialist manufacturing systems expertise for medium-sized U.K.-based manufacturing companies. ICL will lead the partnership and already has a list of software companies in tow:

- Blawie Andrews Computing Ltd.
- Information Engineering Services Ltd.
- MGB Computer Services Ltd.
- Safe Computing (Manufacturing Systems) Ltd.

Software companies admitted to the partnership have to comply with certain ICL standards. ICL specifies that these companies must demonstrate, amongst other things, an in-depth appreciation of the business of manufacturing; a suite of MRPII-based UNIX products that meets the quality requirements of ICL; resources and an organisational structure capable of providing consultancy, implementation services, training,

maintenance and support; a sound financial balance sheet; and a commitment to total quality management techniques.

ICL's partnership manager said, "There is an increasing range of manufacturing systems software available to medium-sized companies. However, research has shown that some such software is well marketed but of poor quality.... The partnership has been established to supply computer-based systems that will help medium-sized manufacturers improve production control, productivity and materials management."

B

Environmental Issues

1. Internationalisation

Computer Associates International received more than 40% of its revenue from sales outside the U.S. in 1989, and approximately 50% of Oracle's revenues were from international sources. Autodesk Inc. has also found major opportunities in non-U.S. markets for its AutoCAD product line.

With the advent of the single European market, Europe will displace the U.S. as the world's largest single market. Therefore U.S. vendors are seeking to expand their customer bases into Europe and to offer products for particular buyer requirements.

2. Workstations and PCs

Workstation manufacturers are convinced that their machines are the way forward for the average corporate PC user and no longer the sole province of engineers and programmers. The major reason for this marketing repositioning is price. For around \$15,000, users can choose between a high-end PC and a considerably more powerful RISC-based workstation such as the SPARCstation 1 or DECstation 3100.

On paper, the UNIX workstation fulfills all the wishes of the disgruntled PC user: 32-bit processing, multitasking, DOS compatibility, network connectivity, very high quality graphics, a WIMP (windows, icons, menus and pixels) interface and a good selection of applications. In fact, the UNIX workstation, if not UNIX itself, is in a great position. It has a three-year advantage in terms of technology and a two-year time gap (whilst the PC market overcomes the limitations of DOS) in which to increase market share.

Probably the biggest factor in favour of the success of UNIX is the lack of success of OS/2. It is probable that one workstation vendor will sell over two million workstations in 1991. This vendor might be Sun, considering the effort it is making with retail distribution. Sun itself hopes to sell more 386s and SPARCstations through dealers in 1990 than through its more traditional channels. However, NeXT Inc. beat Sun into the retail channel when it announced its partnership with BusinessLand.

BusinessLand predicts that it will sell \$150 million worth of NeXT systems in 1990, which amounts to 50% of the UNIX workstation market.

UNIX workstations offer enticing packages to DOS users looking for more power—the users who will design the next generation of successful desktop machines. The Sun 386i is the single UNIX workstation to which most DOS users can relate, and was the best-selling workstation in 1989 in Western Europe. One reason for the immediate success of the 386i (even at twice the price of an equivalent 386 PC) is that it supports UNIX, DOS and OS/2. By buying a Sun 386i, major corporations can begin the transition from DOS to UNIX, but still cover themselves should OS/2 emerge after all. Now, with recent price cuts, the Sun 386i is even more attractive, considering that it comes with four megabytes of RAM as standard.

Digital is another manufacturer interested in attracting desktop users. The new DECstation 3100 certainly looks adequate on paper but a system equivalent to the Sun 386i would cost in the region of £17,000—too much for most power PC users. The diskless version is more attractive at £10,000, especially for six or more users sharing a cheap third-party file server. Although few applications are finished, the biggest appeal of the DECstation is undoubtedly the number of software houses currently developing applications for it.

The availability of applications across different workstations is a must for UNIX to conquer the desktop market. Currently, by virtue of its momentum, UNIX has more applications than OS/2, but it faces the challenge of getting developers to choose a user interface and implement it.

The battle for the desktop will be won by the workstation manufacturer who wins over the greatest number of application developers. The manufacturer with most applications (all conforming to one standard and one interface) will have the edge. The relative price/performance of UNIX workstations will continue to drop on all fronts.

The distinctions between a workstation and a PC are becoming increasingly blurred; both are desk-top machines powered by microprocessors. The differences lie in the tasks each are used to perform. While PCs are commonly used in a wide variety of office automation roles, workstations tend to be used for specialised tasks, such as computer-aided design, financial analysis or scientific calculations.

The concept of computing for Sun consists of linking powerful microcomputers in high-speed networks, rather than many workers sharing a minicomputer or a mainframe. Workstation networks will become the dominant style of the 1990s.

SPARC is only one of several competing chips using RISC, which boosts performance over conventional chips (Intel, Motorola, Intergraph, MIPS). Intergraph is at the top of the RISC league (40%) with Sun second (25%). In addition, increasingly powerful PCs are poised to challenge Sun once they get Sun-like networking and graphics software.

As the market for workstations expands from engineers to office workers, Sun's marketing style may not be effective, since commercial buyers are less interested in performance/price than in solving specific business problems, an area where companies like IBM, Digital and Hewlett-Packard excel. Sun's field maintenance is weak and users complain about Sun's support for its own software.

As profit margins have dropped on after-sale service, Sun is planning to use third-party service engineers who will be trained by Sun. Also, marketing will be revamped; Sun is doubling its budget to encourage software developers to write for SPARC. Sun is teaming with VARs to gain specific accounts, especially in the manufacturing sector. With every equipment vendor preparing to sell the same RISC-UNIX technology, Sun's marketing will be crucial.

With application software for SPARC stations remaining in the scientific and technical field, Sun's deal with Lotus can be viewed as a breakthrough. INPUT's user research reveals significant agreement across all countries with regards to moving applications onto workstations. The power available was considered the most important criterion; the prices of hardware and industry-standard software were the other key issues. Issues are listed in Exhibit VII-2.

EXHIBIT VII-2

Principal Reasons for Moving Applications onto Workstations

Country	Price of Hardware	Power Available	Industry-Standard Software	Total
France	2.03	2.39	1.84	2.09
United Kingdom	2.76	3.49	2.08	2.78
West Germany	2.12	2.65	1.69	2.15
Italy	2.78	4.0	3.0	3.26
Benelux	2.79	2.45	2.82	2.69
Netherlands	2.83	2.49	2.8	2.71
Scandinavia	3.0	4.0	2.5	3.17
Spain	1.07	3.71	1.93	2.24
Rest of Europe	1.75	4.0	2.25	2.67
Total	2.35	3.24	2.32	2.64

Average Standard Error = 0.05

(Rating where 1 = not very important and 5 = very important.)

3. Reasons for Moving to Workstations

The basic reason for moving to workstations is that equipment manufacturers are rushing to bring out successively more attractive and powerful boxes and are seeking to expand their software catalogues through agreements and alliances. Furthermore, as shown in Exhibit VII-3, users do not see fundamental drawbacks with the adoption of workstations.

EXHIBIT VII-3

Principal Drawbacks Associated with Running Applications on Workstations

Country	Insecure	Loss of Control
France	2.1	2.6
United Kingdom	2.2	3.0
West Germany	1.8	1.8
Italy	2.6	1.8
Benelux	2.2	2.4
Netherlands	2.3	2.1
Scandinavia	2.1	1.8
Spain	2.4	1.6
Rest of Europe	2.3	2.8
Total	2.2	2.2

Average Standard Error = 0.05

The frenetic vendor activity in this sector serves as a compelling argument for the enormity of the opportunities available to software companies throughout Western Europe.

NeXT Inc. erased any remaining doubts that workstations will compete directly with the high-end products of major PC manufacturers. NeXT introduced a workstation that can be sold off-the-shelf to business users with a minimum of sales support. Like Apple's PCs, the NeXT machine incorporates a proprietary technology that gives it unique features: a derivative of the UNIX operating system called Mach and a new user interface program to create a machine that is easier to use and program, and higher in performance than the competition.

Hewlett-Packard's acquisition of Apollo represents an aggressive bid to seize a leadership position in the workstation market. It is the first time

in 20 years that HP has undertaken a major takeover. However, it is a good fit, as HP bases most of its workstation products upon Motorola microprocessors but switches to its proprietary Spectrum RISC architecture for very high performance engineering workstations. Similarly, Apollo has Motorola-based workstations and RISC workstations based upon its own PRISM design. Interestingly, Apollo's largest customer, Mentor Graphics, is the leader in the field of CAD systems for the semiconductor industry.

Nixdorf has always bought substantial parts of its product line as an OEM. The majority of Nixdorf's core UNIX product line comes from third parties, and it has now extended its reach in the workstation world (by signing to take Silicon Graphics' three-dimensional CAD workstation to complement those it buys OEM from Apollo). To indicate the importance that U.S. equipment vendors attach to the Western European market, Silicon Graphics has set up its European manufacturing operation in Neuchatel, Switzerland.

The speed of the move to desktop computers is faster than many of the equipment vendors expected. For example, Hewlett-Packard expected that its PC sales would rise by 30% in 1989. They jumped 50%—to about \$4,750 million. By 1990, revenues from PCs, workstations and desktop peripherals (especially HP's LaserJet) will account for 34% of revenues, surpassing its minicomputer sales. With minicomputer sales falling faster than anticipated, this naturally will create problems—for example, margins for desktop products are “only” 40%, whereas for minis they are in the region of 70%.

HP took a 25% stake in Hilco Technologies, a factory software maker, and acquired Eon Systems, a network-monitoring equipment maker, in January 1989. In February it made a 5% investment in 3Com, the PC network supplier, and planned joint marketing and development. In May 1989, HP acquired Apollo Computer. In June, HP licensed Hitachi to use HP RISC processors and made a deal for chip co-development: a month later HP licensed Samsung to use RISC technology and to co-develop workstations.

When HP started in the workstation market, it ignored the software developers whose packages for CAE jobs were popularising Sun and Apollo machines. Instead, HP competed with its own packages. Now HP has changed its marketing approach, opting to concentrate on industry standards and enlist outsiders to help sell HP machines. By acquiring Apollo, HP has won the business of Mentor Graphics, the leading developer of CAE software. Mentor resells Apollo computers equipped with its own software. HP recognised that the paramount concern is winning computer business and not driving away the resellers that can help. As a result, HP is pushing machines through dealers and offering discounts to those that can guarantee specific sales volumes. The push has paid off,

with 70% of HP's PC sales now through dealers, up from 30% two years ago.

The Apollo merger means that customers who bought Apollo's own RISC chip will have to convert their software to run on future versions of HP's RISC design. However, a large percentage of Apollo's customer base (75%) has indicated it intends buying other equipment, especially Sun. Early in 1989, HP reduced the prices of some of its existing workstations by up to 44%.

Digital's RISC DECstation is the product of deal signed between Digital and MIPS and is a departure for Digital, whose previous products have all been based on the VAX architecture. With the adoption of the MIPS chip, the popularity of RISC workstations has been acknowledged by Digital. Certainly by offering a standard UNIX operating system for the new workstations, Digital has moved towards the open systems strategy pioneered by Sun.

The California company MIPS launched a RISC machine with the power of a mainframe but a price of \$250,000. MIPS does not manufacture the chips it designs, but does build computer systems around chips made by its license partners. The number of MIPS chips shipped is expected to soar to 400,000 next year, from 100,000 this year and 10,000 last year. MIPS' turnover, reflecting the success of the technology, has increased from \$14 million in 1987 to an estimated \$100 million this year.

Even the traditional chip companies that once dismissed RISC as irrelevant are getting involved. Both Intel and Motorola have RISC offerings. In the computer sector, Hewlett-Packard uses its own RISC technology and IBM is expected to reinforce its commitment with a new RISC computer workstation.

C

Marketing Issues

1. Attacking the Midrange

The shift to desktop computers is happening fast. As mentioned earlier, HP expected that its PC sales would rise by 30% in 1989. Revenues from PCs, workstations and desktop peripherals will account for 34% and will surpass minicomputer sales.

Intergraph experienced a growth of 83% in terms of units shipped for 1987/1988. However, the company is not considered one of the main contenders, as its main business is selling into vertical markets. In terms of revenue, the sale of system solutions in the areas of design engineering, earth sciences and CAD/CAM has been Intergraph's major area of success. A second business, the Advanced Processor Division, develops and sells the Clipper 32-bit RISC processor that goes into all Intergraph workstations. Intergraph has no choice but to move into the general-

purpose hardware market—otherwise its workstations will increasingly be perceived as proprietary hardware.

As a workstation manufacturer, Intergraph stands alone in the fact that it also produces a wide range of applications. The company's success in producing mainstream technical workstation applications may well deter some software companies from porting competitive products to Intergraph. Of the few third-party applications currently listed in the Intergraph catalogue, the majority are small-niche markets. Potential software developers should consider the 30,000 Intergraph workstations already installed. These workstations are all based on one processor and are all binary compatible with one another.

The company has adopted X Windows and the Open Systems Foundation Motif as its basic applications interfaces. Intergraph was one of the first companies to use Motif and is considered one of the driving forces behind extending X Windows to a full-blown applications interface. Intergraph is not alone in believing that X Windows will not just become the windowing standard of the future but also the application development environment of the future.

Applications developed for workstations are very complex, and a prominent part of any workstation manufacturer's strategy is software engineering. Sun has always concentrated on providing an easy-to-use software development environment in which to port or develop applications. Intergraph has learnt from this philosophy and has a very well respected set of development tools, including a powerful object-orientated development environment (NURBS graphics libraries) as well as all the usual compilers and debuggers. Most of these tools originate from Intergraph's own software development and have therefore benefited from many years' serious use. Third-party software companies that have ported these tools have commented on the relative ease of the port.

Intergraph has compatibility. Whereas Sun now has three independent product lines in the Sun 386i, Sun-3 and SPARCstation range, each of these needs to have applications ported across—not an easy task, especially from Motorola to SPARC.

The key feature of Intergraph's workstations is that each is compatible with its predecessor—one port to Intergraph will last for five years. The heart of an Intergraph workstation, its Clipper processor, can keep pace with a few more generations of processor technology and performance. All Intergraph products are sold via a direct sales force and will make significant inroads into the midrange. Vendors' attitudes are summarised in Exhibit VII-4.

EXHIBIT VII-4

The Midrange under Attack

Vendor Attitudes

Negative

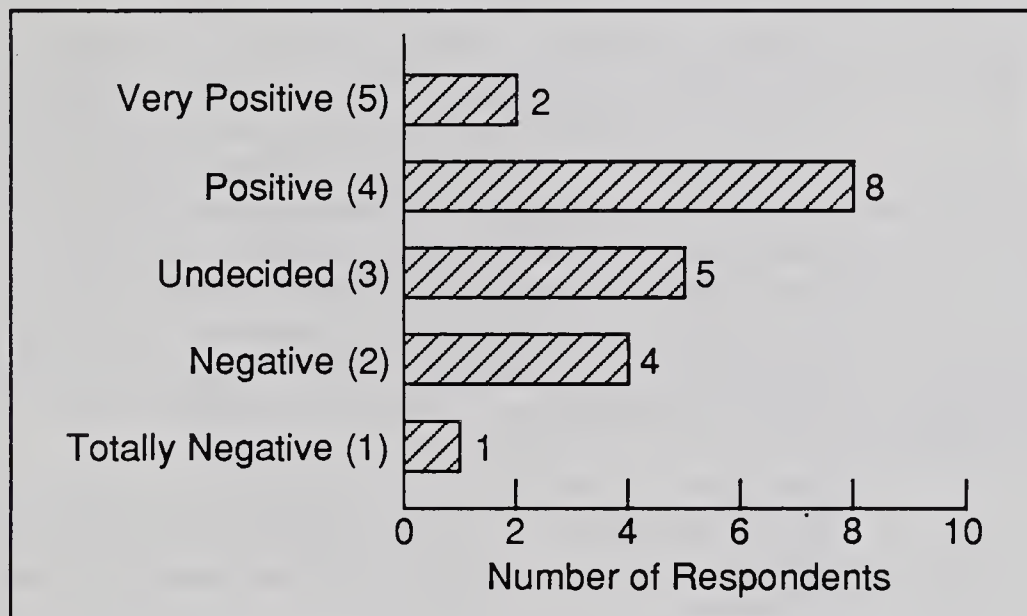
- IBM AS/400 is more important.
- Workstation installed base is still (relatively) small.
- Workstations are too specialised.

Undecided

- In the long-term yes, right now it's a problem for us.
- Equipment is less important; users are looking for solutions.

Positive

- If the standards issues are resolved, then yes.
- Minicomputers are no longer the future; workstations are the platform for the 1990s.



(More results in response to the question: "Could you indicate on a scale of 1 to 5 whether you see that the development of the workstation as a competitor to the minicomputer is good for software vendors?")

2. Channel Strategy

Open systems was the 1989 catchphrase. With the U.K. Government insisting on open systems for all its own requirements, there are many lucrative opportunities for developers of business in the UNIX and DOS environments. Open systems platforms based on UNIX and OSI promise

VARs the power to change suppliers at will. Meanwhile, standardisation and the 1992 initiative will create a new kind of homogeneous market in which suppliers will want to place a major share of their direct sales force.

In Europe, UNIX accounts for 15% of all IT systems sold, which represent an estimated \$3.7 billion in 1989 (29% of the world market). Growing as fast as it takes share from proprietary operating systems, INPUT estimates that the open operating system will reach 20% of the European market by 1991. To do so, it will need to break out of its traditional, technical and small multiuser systems niches and take large parts of the markets for commercial systems.

In the long term, open systems may lead to the dismantling of users' DP departments and the growth of new kinds of external systems integration services. But in the short term, open systems are intensifying the love-hate relationship between VARs and suppliers. So far in Europe, UNIX has been sold more by VARs than by direct sales forces—with the notable exception of workstations, which tend to be sold directly.

For example, IBM's Advanced Workstation Division has been given responsibility for UNIX on PS/2 and on IBM mainframes. IBM says that there are more than 20 million small and medium-sized businesses worldwide that are potential users of a UNIX-based network. A multi-user UNIX supermicro is a much better candidate in this market-place than any other of IBM's current offerings. With the Advanced Workstation Division in charge of UNIX and all the machines from the 360 mainframe to the PS/2 micros, the potential for growth is enormous. The result could be that UNIX will not only become one of IBM's operating systems, but also a central feature of the large IBM end-user world.

The amount of effort IBM is putting into the Advanced Workstation Division is impressive. Although there is no doubt that this is one of IBM's biggest-ever ventures, there are doubts about the problems facing the channels with the expertise to sell workstations and higher-end PCs. A new type of channel is likely to evolve, because the scope of most VARs is too narrow to cope with the expected demand for these products, and traditional PC dealers are ill-prepared to handle them. However, until this channel evolves, IBM may well find itself in the position of having machines that everybody wants and no channels through which to sell them.

The Santa Cruz Operation (SCO) has probably 90% of the low-end UNIX market with its XENIX or UNIX 386 products, the best-developed UNIX system for a PC. It would be fair to say that though SCO was originally a second source for XENIX, today it is XENIX.

To complement XENIX, SCO has a catalogue of applications, most of which are products of other companies remarketed by SCO. These applications range from Foxbase (a dBase III look-alike) to a XENIX X Windows system. A recent agreement with Sun has resulted in SCO's developing applications for the Sun 386i as part of Sun's push into the desktop PC market.

SCO targetted selling UNIX into a business environment by creating a low-end UNIX called XENIX that retained all the features of UNIX that so attracted disenchanted MS-DOS users, but removed some of the academic bias. In the process, SCO found itself a niche between a porting-style consultancy that provided service and custom work, and a mainstream retail software sales outlet such as Lotus, where support is mainly left to the dealer who sells the product.

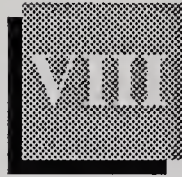
SCO has called this technique "value-added distribution," and is one of the few successful distributors that has developed the knowledge to sell low-end UNIX business software. Although SCO has a significant lead over the competition in selling low-end UNIX business software, it is not alone in this respect. Other UNIX companies are getting into the market, as well as the DOS software companies that are offering UNIX versions of their products and selling them directly through existing outlets.

As well as being threatened from below, SCO is being pressurised by Digital and IBM, which are attracted by the market. SCO's new arrangement with Microsoft allows Microsoft to purchase up to 20% of SCO. The two companies are cooperating in producing a version of Presentation Manager that runs under UNIX and X Windows, essentially to promote OS/2. The two will also develop LAN Manager/X, a UNIX/X Windows version of the Microsoft OS/2 LAN Manager. What the arrangement means for UNIX is unclear, but it provides SCO with a powerful ally.



Conclusions and Recommendations





Conclusions and Recommendations

The workstation market has been affected by the emergence of networks and distributed and cooperative processing. Users in Western Europe are looking to software products vendors for help in creating a cost-effective, efficient information environment. This environment should be totally integrated with the latest technology and be flexible enough to grow to meet future requirements.

Emerging technology is enhancing and complicating the workstation application software market as new chip technology expands the power of the workstation. These new capabilities will make the workstation more efficient for many applications that have traditionally been run on mainframes. Bringing processing to the workstation level will mean more distributed sharing of processing and information. A summary of the workstation application software issues is given in Exhibit VIII-1.

EXHIBIT VIII-1

Summary of Workstation Application Software Issues

- Cooperative networking
- Distributed processing
- Integrated tools
- More power to user
- UNIX
- Graphics user interface
- Application performance

The priorities in purchasing a workstation are the following:

- MIPS
- Good graphics
- UNIX

In 1989, 35% of installed workstations were doing CAD/CAM, simulation, analysis and engineering, with a further 35% carrying out software engineering. Approximately 5% were used as network servers. Although users of UNIX-based technical workstations have more choices than ever with which to run their MS-DOS applications, DOS co-processors and software emulators have yet to gain a firm hold in the UNIX marketplace. Emulation of one environment doesn't necessarily provide the best of both worlds.

INPUT's research leads to a conclusion that nearly half an engineer's time at UNIX workstations is consumed by nonengineering work; 40% of general use of workstations is for business tasks, such as electronic mail, graphics presentations, report writing and budgeting. In fact, the largest application is for word processing.

One of the most critical factors in selecting an engineering workstation is application performance, which depends on CPU input/output, operating system software and graphics. Balancing these components is essential to achieving maximum machine performance. As a result, engineering organisations accessing workstations should not limit their comparisons to a single specification such as MIPS. Instead, they should look for a balanced architecture, especially between general-purpose and graphics processing.

The ideal mix of components varies with the application. For example, visualisation requires a high number of graphic instructions. A workstation's CPU rating alone may not represent the actual performance in these applications. CPU ratings would, in this instance, be more indicative of expected applications performance when processing simulations and carrying out exhaustive analysis that involves an enormous amount of computational calculation.

Powerful engineering workstations will be required to process the increasing complex and sophisticated engineering applications. Many of these tasks involve extensive graphics processing designed to increase productivity through pictures, menus and other elaborate functions. Human-interface mips (ease-of-use, graphics) will become the most important element in computing in the next decade.

INPUT forecasts a dramatic increase in human-interface mips use in the PC market. Because workstation graphics are 4 to 5 years more advanced than PC graphics, it is for workstations to address human-inter-

face processing for engineering departments and thus realise significant productivity gains.

Higher performance in an engineering workstation translates to shorter response times: productivity increases exponentially when response times drop below one second. Typically, the faster the computer, the shorter the response time. With large and complex graphics, so many instructions are required that response times worsen.

INPUT does not believe that it is an exaggeration to say that the basic personal computer (PC) is unused for 50% of the working day. The low cost of the rudimentary microprocessor has turned the basic PC into an item on a par with the WC—the key issue concerning performance is availability on demand. However, the high-performance workstation must be judged by different criteria. The users of workstations have professional skills thought to be capable of effecting leverage on business profitability. The aim is to achieve competitive advantage.

In this context, the evolution of UNIX as the most likely operating system for the workstation market does pose problems: UNIX has text-based presentation. The very workstations exploiting UNIX's features are geared to making information handling the foundation of visual aids for scientific development, engineering product development, robotic control and communication through animation. Yet because of the history of UNIX, it is bereft of visual aids to communicate to the majority of users. The "landscaping" of UNIX is currently being developed under the Open System Foundation's (OSF's) Motif.

There are further differences between PC and workstation capabilities. The most powerful versions built from the basic PC are hardware platforms that can work at the low end of the workstation field as well as act as powerful PC application delivery engines. However, the PC is still rooted in the one-thing-at-a-time philosophy, whilst workstations are multitasking machines. Even where PCs are hooked into a network, there tend to be some sharp distinctions. The interworking of PCs is usually aimed at sending results from one unit to another, extracting files from main databases and sending messages across the network. The workstation user does all of these things but is also trying to establish the distributed computing idea.

In full distributed computing, the workstation user may well call upon resources outside the immediate desktop to carry out special portions of a single application—i.e., a workstation user wishes to view the network as a means of access to all types of computing resources. In this area it is significant that the members of the OSF (Hewlett-Packard, IBM and Digital) have taken out licenses to the NCS (Network Central System) pioneered by Apollo. Until recently, the PC network has focused on queuing work for an expensive printer and stage-by-stage build-up of reference files for users to access.

In other words, the previously separate worlds of PC networking and workstation-based forms of distributed computing are going to merge more and more. Distributed computing systems that are truly open and accessible are still under development and pose fascinating challenges that have to be met if cooperative communities of professionals are to be satisfied with their pool of computing resources. There is general agreement in the industry that users need a familiar “driving seat” that retains a familiar feel as they learn to transfer from limited to extensive computing resources.

Although the significance of achieving portable applications that transfer across differing machines is technically understood, the commercial realities are somewhat different. There is a debate over what is meant by an open system. The term was first used to describe the telecommunications companies’ method of producing compromises that worked, but that were not particularly cost-effective for the user. Currently the disparate clumps of computing in most user organisations are an “imagined” single resource. On the ground, there are users and suppliers who are in the act of pouring glue over the hardware and software in an effort to meet the concepts of strategic planners.

First there has to be some examination of providing a seamless platform for UNIX workstations and the arrival of Microsoft’s OS/2 as an alternative base for popular applications. There will be a need for a Binary Compatibility Standard so that calls to the underlying standard can be correctly handled by both candidates’ operating systems. At the moment, the Motorola 88000 chip is the most likely option for such “deep” portability. There exists an 88 open consortium that has designed a binary standard believed to be aimed at linking applications across the Microsoft scheme for conventional desktop use, all the way to advanced UNIX-based technical workstations.

INPUT believes that most microprocessor designs that are geared to both the high-end personal computing user and the technical workstation area, and that exploit hardware co-processors for display purposes will be “stuck” together by binary compatibility definitions and interfaces. The news that OS/2 will be POSIX compatible (allegedly the aim of all UNIX developers) means that Western Europe should be littered with applications able to be truly portable across both types (UNIX and OS/2) of operating system within the next two years. The key point about portability is that *open systems* is becoming a term that means moving across operating systems types, and is certainly not confined to using UNIX, which is only a model for the POSIX concept.

However, for the immediate future, the UNIX option is the platform for portability for graphics minisupercomputers of the Apollo 10000 type. Management will limit its exposure to higher priced boxes by adopting a UNIX workstation strategy.

The fading distinctions between personal computers and technical workstations derive from their origins. The idea of multitasking was not built into the mass-marketed applications for the IBM-compatible PC market. UNIX, however, has been exploiting multitasking for years. The connecting part has come from the use of the PC AT bus as incorporated in all large vendors' workstations.

In Western Europe, INPUT estimates that there will be \$1.5 to \$2 billion spent on UNIX workstations and high-end PCs. Much of this spending will go towards software and its development, but it is difficult to predict how the total will break down between the PC and the workstation tailored to specified capabilities. Nevertheless, as Exhibit VIII-2 indicates, the environment in the 1990s will provide an enormous number of opportunities in the fast-moving technological market.

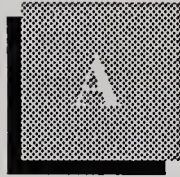
EXHIBIT VIII-2

The Environment in the 1990s

- PC networks and workstation-based distributed computing will merge
- Truly "open" systems
- Seamless platform for UNIX workstations
- Portable applications
- Increased spending on software



Appendix: Definition of Terms



Appendix: Definition of Terms

A

Revenue

- *Captive Computer Services Revenue* - Revenue received from users who are part of the same parent corporation as the vendors.
- *Noncaptive Computer Services Revenue* - Revenue received for computer services provided from users who are not part of the same parent corporation as the vendor.
- *Other Revenue* - Revenue derived from lines of business other than those defined above.
- *Total Company Revenue* - Revenue received from total computer services and other sources of revenue.
- *Total Computer Software and Services Revenue* - Revenue received from services provided by vendors that perform data processing using the vendors' computers (processing services), assist users to perform such functions on their own computers (software products and/or professional services), provide a combination of hardware and software integrated into a total system (turnkey systems), include consulting, education and training, programming analysis, and facilities management (professional services), provide for systems design, integration and installation (systems integration), or offer network, enhanced management services, electronic mail, electronic data interchange, or electronic information services (network services).

B

Service Modes

- *Processing Services*
 - Transaction Services: uses vendor equipment and software at vendor site or customer site; may be interactive or remote-batch-oriented.

- Utility Services: access to basic software tools enabling the users to develop their own problem solutions (language compilers, assemblers, DBMS, sorts, scientific library routines, etc).
- Other Services: carry-in batch processing, computer output microfilm services (COM), data entry services, disaster recovery/backup services.
- Facilities Management (Systems Operations): vendor provides a complete operating information system for customer including equipment, software, personnel and facilities.
- *Professional Services* - Management consulting activity related to EDP systems consulting, production of custom software, education and training, and systems operations of client-owned computers (formerly identified as facilities management), where the vendor provides human resources to operate and manage the client facility.
- *Systems Integration* - delivery of large, multidisciplinary, multivendor systems, incorporating some or all of these functions: systems design, programming, integration, equipment, networks, installation and acceptance. Systems can encompass multiple product delivery modes.
- *Software Products*
 - Systems software and/or applications software packages purchased by users.
 - Systems Software Products

Systems Control Software: operating systems, communications monitors, network control, library control, windowing, access control, security, etc.

Data Center Management Software: capacity management, scheduling, job accounting, performance monitors, tape management, utilities, downtime/repair monitoring management, etc.

Application Development Tools Software: application generators, assemblers, compilers, 4GLs, automated documentation, languages, translators, database management systems, data dictionaries.
 - Applications Software Products

Cross-Industry Applications Software: used by clients in many or all vertical markets (i.e. payroll, word processing, spreadsheets, accounts receivable).

Industry-Specific Applications Software: unique to a specific vertical market and sold into that market only (i.e., demand deposit accounting, MRPII, hospital patient tracking).

- *Network Services*

- Network Management and Enhanced Services: network management functions, network transmission facilities, augmented with computerized switching and features such as packet switching, electronic mail, store-and-forward message switching, terminal interface and error detection and correction.
- Network Applications
 - Electronic Data Interchange (EDI): application-to-application electronic communication, based on established business document standards.
 - E-Mail: a range of services that transmits documents consisting of text and graphic material to be read by a person—with the quality of document being high.
 - All other application services in which the network is the principal part of the service, e.g., electronic funds transfer and some videotex services.

- *Electronic Information Services*

- Databases that provide specific information via terminal-based inquiry such as stock prices, legal precedents, economic indicators, airline schedules, etc.
- News services that offer current information, either general or for a specific category; i.e., financial or political
- Other services that provide interactive access to databases and offer the inquirer the capability to send as well as receive information for such purposes as home shopping, home banking, travel reservations, etc.

- *Turnkey Systems* - an integration of systems software, packaged or customized applications software, CPU, equipment, and peripherals. These systems are developed to meet a specific set of user requirements. The value added by the vendor is primarily in the software, either packaged or custom-developed. Most CAD/CAM systems and many small business systems are turnkey systems. This does not include specialized hardware systems such as word processors, cash registers, and process control systems.

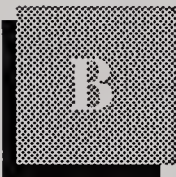
C

Other Considerations

When questions arise about the proper place to count certain user expenditures, INPUT addresses them from the user viewpoint. Expenditures are then categorised according to what users perceive they are buying.



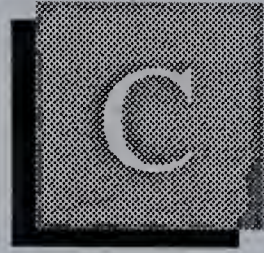
Appendix: Analysis of Research Sample



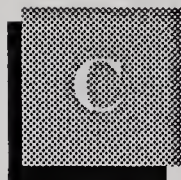
Appendix: Analysis of Research Sample

EXHIBIT B-1

Analysis of Research Sample		
Country	Vendors	Users
Pan-European	6	—
France	4	40
United Kingdom	6	40
West Germany	4	40
Italy	3	20
Benelux	2	20
Scandinavia	2	20
Spain	2	10
Rest of Europe	1	10



Appendix: Vendor Questionnaire



Appendix: Vendor Questionnaire

Workstation is defined as: Single user, high performance, e.g. 68030 or 80386-based bit-mapped screen with graphics output, WIMP user interface.

Application software is limited to that also available on more traditional platforms

1. Company_____

Contact, title _____

	<u>Product</u>	<u>Percent of Revenues</u>	<u>Segment*</u>
Main products (or product lines)	1. _____	_____	_____
	2. _____	_____	_____
	3. _____	_____	_____

* i.e. cross-industry : accounting, human resources, education and training, planning and analysis, engineering and scientific, and other or industry-specific: banking and finance, discrete manufacturing, education, federal government, insurance, medical, process manufacturing, retail, services, state and local government, telecommunications, transportation, and utilities.

2. The Move to Workstations

- QU: 2.1
- Are you considering moving your software onto workstations?
- QU: 2.2
- What is the primary motivation for this decision?
- QU: 2.3
- Would this be a move up from a micro or down from a mainframe?

QU: 2.4 How important do you rate the following reasons for or against a move?

	Strongly For	For	Irrelevant	Against	Strongly Against
Ability to offer enhanced product	_____	_____	_____	_____	_____
- Price/performance	_____	_____	_____	_____	_____
- Better user interface	_____	_____	_____	_____	_____
- More power per user	_____	_____	_____	_____	_____
- Other	_____	_____	_____	_____	_____
Reflects departmental organisations	_____	_____	_____	_____	_____
Response to competitive pressure	_____	_____	_____	_____	_____
Exploit installed base	_____	_____	_____	_____	_____
Other	_____	_____	_____	_____	_____
Comments	_____				

QU: 2.5 For your three main products listed above, when do you expect them to be available on a workstation, and when making good use of the user interface?

	Mounted	Good use
Product 1.	_____	_____
Product 2.	_____	_____
Product 3.	_____	_____

QU: 2.6 How big do you believe the market for this sort of workstation software to be in this country (i.e., country of interview)?

	Now	1991
Percent of total software product sales	_____	_____

QU: 2.7 Who will be the top three competitors in this workstation-based market in the next couple of years?

3. Workstation Platforms

Operating Systems

QU: 3.1 In what proportions by value do you think you will deliver your software on the various operating systems?

	Percent Now	Percent 1991
UNIX	_____	_____
OS/2	_____	_____
MacOS	_____	_____
Other (specify) _____	_____	_____

Comments_____

Hardware

QU: 3.2 And in what proportions by value will you deliver by manufacturer?

IBM PS/2	_____	_____
IBM Other (specify)	_____	_____
DEC Ultrix (UNIX)	_____	_____
DEC VMS	_____	_____
Sun	_____	_____
HP/Apollo	_____	_____
Other (specify)	_____	_____

Comments_____

QU: 3.3 How would you rank the factors that limit the range of platform on which you will mount your software? (1=least important, 5=most important)

	Rank
Cost of development	_____
Cost of sales	_____
Cost of support	_____

Comments_____

Networking

QU: 3.4 What percentage of the workstations on which your software is installed would have to be networked for the purposes of running your software (apart from access to a file or print server)?

_____%

QU: 3.5 Do you expect your software to be running on a variety of machines on one network, even though they perform the same task?

___ Often ___ Sometimes ___ Never

QU: 3.6 Conversely, do you expect the workstations to have enhanced software to provide additional functions/features, (e.g. graphics output, AI) and be networked with more limited machines?

___ Often ___ Sometimes ___ Never

Comments _____

Cooperative processing

QU: 3.7 As an alternative approach, do you expect to develop your software to be delivered by cooperative processing (i.e., workstation linked to more powerful machines, each doing the part of a task best suited to it) over the next couple of years?

___ Yes ___ No

Comments _____

4. Standards

QU: 4.1 How do you rate the necessity of adhering to and providing for these standards?

	<u>Essential</u>	<u>Very Important</u>	<u>Important</u>	<u>Not Very Important</u>	<u>Irrelevant</u>
SAA	_____	_____	_____	_____	_____
X Windows	_____	_____	_____	_____	_____
NFS	_____	_____	_____	_____	_____
TCP/IP	_____	_____	_____	_____	_____
Other (specify) _____	_____	_____	_____	_____	_____
Other (Specify) _____	_____	_____	_____	_____	_____

Comments _____

5. Sales Considerations

QU: 5.1 What will be the principle distribution channel for selling workstation-based software?

Is this different from the current route? _____

QU: 5.2 Will sales be turnkey or straight software?

QU: 5.3 What extra (or less) skills will be needed to support software if it is based on workstations? e.g., support of network, different training, etc.?

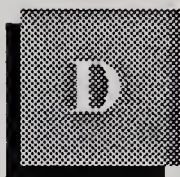
QU: 5.4 How do you expect pricing on a workstation to be set?

[Prompt: Premium price for enhanced features
Low price for volume
Priced per single-user workstation
Priced proportional to platform power]

Comments



Appendix: User Questionnaire



Appendix: User Questionnaire

Good _____. My name is _____ and I am ringing you on behalf of INPUT, an international research and consultancy organisation specialising in the field of computer-related services.

I would like to ask you some questions about your use or potential use of workstations and midrange computer systems, in particular your needs and experience of software application products that are run on these systems.

[NB: The bounds of the market sector being examined are defined by the **exclusion** at one end of mainframes, and at the other of PCs.]

[Workstations can either be single or networked together.]

QU: 1 I would like to establish the make and model number of the workstation **or** midrange system that you use for running software application products?

Midrange System (Mini)

Make _____

Model _____

Units _____

Workstation

Make _____

Model _____

Units _____

NB: If respondent has no experience or responsibility for application products running on workstations **or** midrange products, then interview should be terminated.

QU: 2 First I would like to ask you some questions specifically about your attitude to running applications on workstations.

(If respondent has workstations installed (See Q1) answer Q2a.)

a. What applications are you currently running on your workstations and are these packages custom-built or in-house-built applications?

<u>Application House</u>	<u>Package</u>	<u>Customer</u>	<u>In-house</u>
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(If respondent does not have workstations installed (See Q1) answer Q2b.)

b. Are you planning to utilise workstations for running applications in the future, and if so, what particular applications are planned? If No go to question 4.

YES

Application (please write in)

Comments:

QU: 3

What are the principal reasons for moving applications onto workstations? Please indicate on a scale of 1-5 (1 = not very important, 5 = very important) the weight you would place on each factor.

<u>Factor</u> (Prompt if necessary)	<u>Rating (1 - 5)</u>
Price of hardware	_____
Power available	_____
Industry standard S/W e.g., UNIX	_____
Other (please write in)	_____
_____	_____
_____	_____
_____	_____

Comments:

QU: 4 What do you consider to be the drawbacks/problems associated with running applications products/systems on workstations? Please indicate on a scale of 1-5 (1 = not very important, 5 = very important) the weight you would place on each factor.

<u>Factor</u> (Prompt if necessary)	<u>Rating (1 - 5)</u>
Insecure	_____
Loss of control	_____
Other (please write in)	_____
_____	_____
_____	_____
_____	_____
Comments:	

QU: 5 How would you rate the following application areas in terms of the desirability of running application software products on workstations? Please rate on a 1-5 scale where 1 = not desirable at all, 5 = very desirable.

<u>Application Type (ROTATE)</u>	<u>Rating</u>
Accounting	_____
Planning and Analysis	_____
Finance	_____
Payroll	_____
Administration	_____
Personnel	_____
Sales/Distribution	_____
Stock Control	_____

Office Automation/ Communication	_____
Production control	_____
Technical (Please define)	_____
Educating/Training	_____
Other (Please write in)	_____
_____	_____
_____	_____
_____	_____

Comments:

QU: 6 a. Have you acquired or would you consider acquiring complete application systems i.e., the hardware (plus all necessary peripheral or associated equipment) and the applications software are provided together along with any necessary customisation and support? Please rate the following on a scale of 1-5 where 1 = not very attractive, 5 = very attractive.

	<u>Rating</u>
Have acquired in the past	_____
Would consider in the future	_____
Would not consider	_____
Other (please write in) _____	_____

POSITIVE RESPONSE

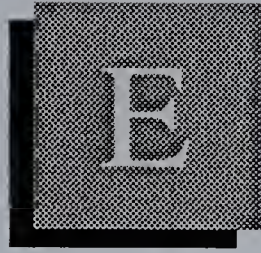
b. What applications and why?

<u>Application</u>	<u>Reasons</u>
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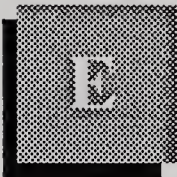
Comments:

NEGATIVE RESPONSE

c. Why would you not consider this approach?



Appendix: Detailed Forecast Data



Appendix: Detailed Forecast Data

EXHIBIT E-1

Detailed Forecast Data

Country	Currency	User Expenditures (Local Currency)						1989-94 CAGR (Percent)
		1989	1990	1991	1992	1993	1994	
France	FF (M)	330	520	760	1,040	1,420	1,770	40
United Kingdom	£ (M)	32	50	73	100	136	170	40
West Germany	DM (M)	100	160	240	330	450	560	40
Italy	Lira (B)	50	75	110	157	215	270	39
Benelux	BF (M)	650	1,200	1,750	2,500	3,250	4,050	44
Scandinavia	SK (M)	105	190	280	385	525	655	44
Spain	Pst (M)	1,815	3,200	4,700	6,400	8,700	10,890	43
Rest of Europe	\$ (M)	8	18	30	45	64	80	58

M = Million
B = Billion

